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Of Ice Planets, Bog Planets, and Cities in the Sky 4

As special effects supervisor for *The Empire Strikes Back*, Richard Edlund was responsible for reestablishing the *Star Wars* effects facility and presiding over the production of some four hundred optical effects shots. A seasoned veteran of the original Lucasfilm epic, Edlund discusses how three years of advancing technology, coupled with a top-notch technical crew, enabled ILM to segue into an even more complex project — and with better results. *Interview by Don Shay.*

Greg Jein — Miniature Giant 24

From a less than auspicious beginning sculpting spacecraft models for porno parodies and student films, two-time Oscar nominee Greg Jein has become — in five short years — one of the giants in the field of movie miniatures. In addition to detailing his early work, accounts are provided of his landscapes and mothership for *Close Encounters of the Third Kind*, the remarkably detailed settings for *1941*, the V'ger interior and spacewalk props for *Star Trek — The Motion Picture*, and the add-on work for the *Close Encounters* reissue. *Article by Brad Munson.*

Star Trekking at Apogee with John Dykstra 50

Approximately one third of the optical work in *Star Trek — the Motion Picture* was produced under the supervision of John Dykstra at his Apogee effects facility. Covering Apogee's involvement from stem to stern, Dykstra discusses in detail the Klingon and Epsilon 9 sequences and the exterior V'ger passage. He further elaborates on Apogee's approach to the digitization and energy probe effects, as well as some old standards such as transporter beams and photon torpedoes. *Interview by Don Shay.*

FRONT COVER — Imperial walkers on the attack in *The Empire Strikes Back*.
The alien mothership from *Close Encounters of the Third Kind* — BACK COVER.

Of Ice Planets, Bog Planets and Cities in the Sky

Richard Edlund discusses the technological advances that enabled Industrial Light and Magic to wrest the 'Star Wars' saga from the matte-line haven of outer space and project it into even more optically foreboding environments.

interview by
Don Shay

MITCHELL CAMERA CORP.

If ever a film was destined for sequeldom, Star Wars *was it. George Lucas' whirlwind venture into ancient times and distant galaxies struck an immediate and resounding note upon its release in 1977, prompting audiences worldwide to surrender more than $400,000,000 at the boxoffice in direct tribute to the picture's unyielding capacity to enthrall and entertain. Even before the film was released, however, Lucas had envisioned it as but one chapter in an ongoing saga, and within months had launched into preparation of a second installment,* The Empire Strikes Back.

Star Wars — *rechristened* A New Hope *in belated acknowledgment of its place in the overall* Star Wars *opus — was filmed primarily at the sprawling EMI Elstree Studios near London. Its voluminous special effects, however, were engineered and executed thousands of miles away at Industrial Light and Magic, an all-encompassing optical facility formed under the direction of effects supervisor John Dykstra (2:50-71) specifically for that purpose. A key member of Dykstra's ILM team was first effects cameraman Richard Edlund.*

Edlund brought to the production a diversified background in motion picture and special effects photography. Born in Fargo, North Dakota, he gained a basic knowledge of photographic systems and techniques in the U.S. Navy and at the University of Southern California. He spent four subsequent years in the employ of his longtime friend and mentor Joseph Westheimer, working on television commercials and on primitive opticals for series such as The Outer Limits, The Twilight Zone *and* Star Trek. *Ultimately he left the firm to work unencumbered as a freelance still photographer and promotional filmmaker for a number of prominent rock groups. After that, he joined Robert Abel and Associates where his talents were put to use on a variety of sixty-second extravaganzas which for years were the Abel trademark in television commercials.*

Edlund was hired onto the Star Wars *effects unit in 1975, and spent the next two years utilizing Industrial Light and Magic's innovative motion control technology in the photography of spacecraft miniatures. When effects work on* Star Wars *was completed, the ILM unit remained basically intact throughout the early segments of* Battlestar Galactica *until John Dykstra withdrew from the series and Universal established its own in-house effects capability. Edlund then photographed the miniature effects sequences for* The China Syndrome *before responding to the call to be special effects supervisor for* The Empire Strikes Back. *Implicit in the offer, however, was the proviso that Industrial Light and Magic be moved from its original site in Van Nuys to the Lucasfilm base camp north of San Francisco.*

Preferring a more detached role than the one he had essayed on the first Star Wars *outing, George Lucas relinquished directorial reins to Irvin Kershner, electing instead to be executive producer. In addition to the extensive studio work — much of it filmed on one of the world's largest soundstages, constructed especially at EMI Elstree to house the oversize sets for* The Empire Strikes Back — *Kershner also led a subzero shooting expedition onto the Hardangerjokulen Glacier in Norway. Edlund, meanwhile, was engaged in a two-year drive to organize and execute the elaborate special effects required for the film. Since Lucas had perceived the need to liberate his saga from space-bound stagnation, many elaborate effects sequences had been incorporated in settings and environments which would have been essentially impossible to realize with the technology already available from the earlier film. Clearly, Edlund and his associates had their work cut out for them.*

How did you go about reestablishing Industrial Light and Magic in Marin County?

There were about six or eight of us from the original effects crew that decided to follow the *Star Wars* saga into northern California — actually more than that, but about six or eight in the key staff positions. Dennis Muren and I had split most of the model photography in *Star Wars* and we decided that we would work together again on *Empire* — he became the director of photography. I was able to convince Bruce Nicholson that he could, and should, become head of the optical department. Peter Kuran became head of our animation and rotoscope department. Lorne Peterson, our model shop chief, and Steve Gawley, our model shop foreman, were also veterans. Phil Tippet and Jon Berg took on the much expanded stop-motion work in *Empire.* And then, in head of our electronics shop we had Jerry Jeffress. So we had kind of a basic core of people with a lot of corporate knowledge and a solid working relationship already established.

The facility itself was a new building — empty like the old Industrial Light and Magic was when we first started gearing up for *Star Wars.* We did bring along with us some of the original equipment, though, including the main tracking camera, the matte camera, and an optical printer. But that still left a lot of serious holes in our equipment inventory; so one of my first concerns was designing and getting the rest of the equipment we'd need constructed, and also restaffing the entire facility.

You and Brian Johnson shared supervisory credit for special visual effects. How did you interface?

Brian's forte is in getting the organization together to produce all the physical effects that are done during the principal photography. My expertise is in photographic effects involving miniatures, motion control photography, slow-motion, and traveling matte work — the technical aspects of all these weird processes. So I was in charge of the Industrial Light and Magic facility. Brian was there, and he contributed during that period, but he was really more involved in what was happening in London and what was happening in Norway — fog and explosions and rigs to cause weird things to happen. He was also in charge of rebuilding R2-D2 and getting it to respond properly to radio

Like its predecessor, The Empire Strikes Back *was filmed primarily in England. Its special effects, however, were produced at Industrial Light and Magic in San Anselmo, California. In charge of the more than four hundred optical effects shots in the picture was* Star Wars *veteran Richard Edlund. Nearly two years were devoted to equipping the ILM effects facility, assembling a crew, and producing the required footage.*

The Empire Strikes Back *photographs copyright © 1980 by Lucasfilm Ltd. All rights reserved. Special effects unit still photography by Terry Chostner and Howard Stein.*

control signals.

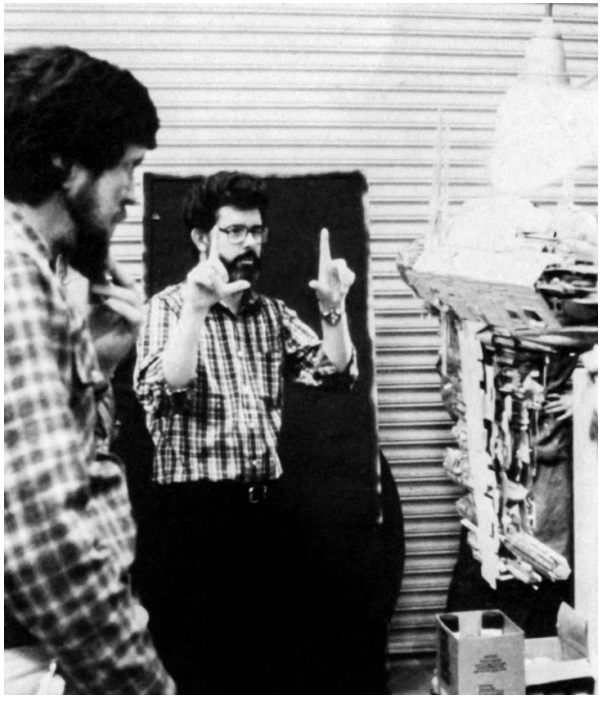
The two main projects I started with were the design and construction of a special optical printer to do our composites and a high-speed VistaVision camera. VistaVision is a large format 35mm system that feeds film through the camera horizontally rather than vertically, so you end up with an image about twice the size of normal 35. Since all the material we shoot has to be duplicated, we've found that you don't lose nearly as much quality if you start with a big negative. I chose VistaVision format over 65mm, because 35mm film stock is easier to work with and the equipment is far less cumbersome. But there were no VistaVision cameras anywhere that would run over thirty-six or forty frames a second, even if you were pushing it. So we had to construct one, and I commissioned the Mitchell Camera Corporation to build us the movement.

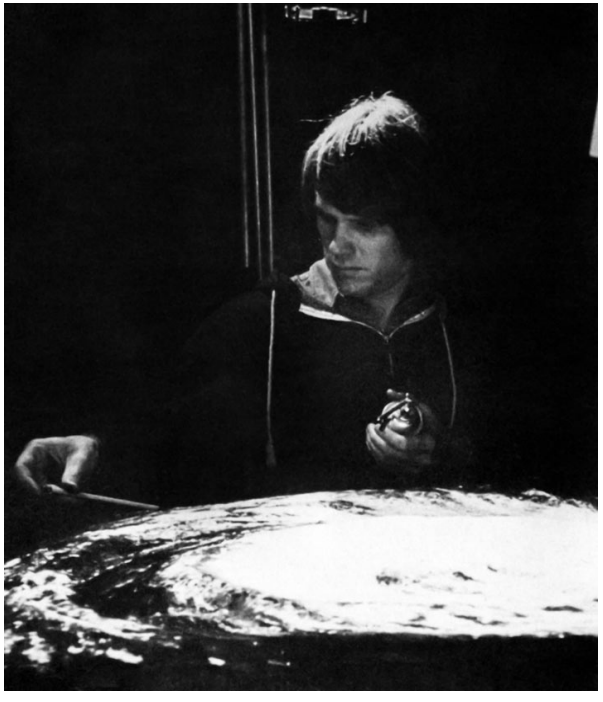
At the same time, I was working with George Randle on getting the cameras and movements built for the optical printer, and with David Grafton who was designing the special optics. We had to build our own printer from scratch, because the standard optical printers that you find in this business are really geared more for your basic fades and dissolves and blowups and things like that — not for intricate composite photography. As a result, they were simply not adequate for the quality of work we had in mind.

The exciting thing about this project, from the standpoint of equipment and technique, was that it would be an on-going situation and not one that would be formed for just one production and then disbanded. So we're sort of building a monument here. All the equipment we have is designed in such a way that it is totally interfaceable, and the grand design of all the electronics equipment — which is Jerry Jeffress' forte — is based on the concept that everything we make now is computer-controlled. Therefore, it is malleable in that you can change the function of it by reprogramming the computer. The composite printer, for example, has a very complex electronics system which is based on this principal, so it's not likely to become obsolete nearly as fast. If you have a piece of equipment which you want to perform some function which it didn't need to do before, instead of tearing into the machine and changing a bunch of wires and then taking it off-line for two weeks while you debug it, you can do it all in the electronics department. Then all you have to do is take a new chip and plug it into the system and you're down for maybe five minutes.

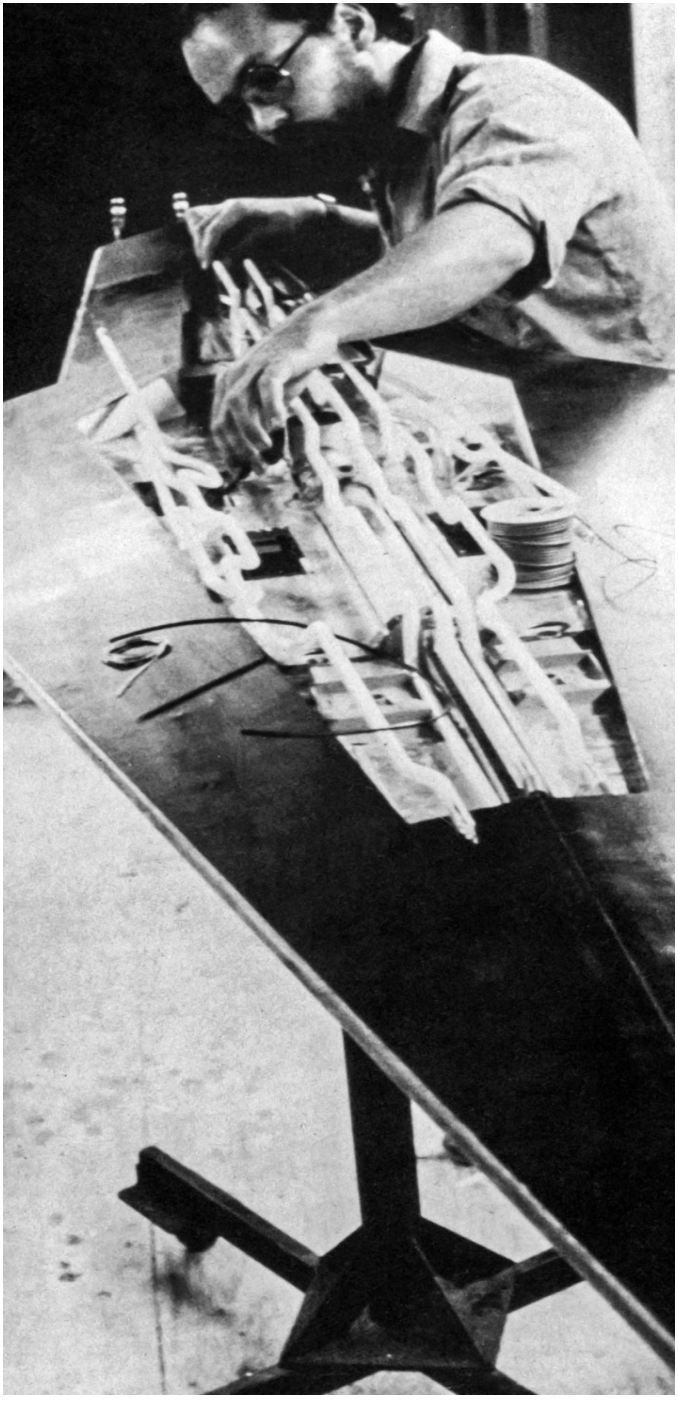
What are the particular capabilities of your optical printer?

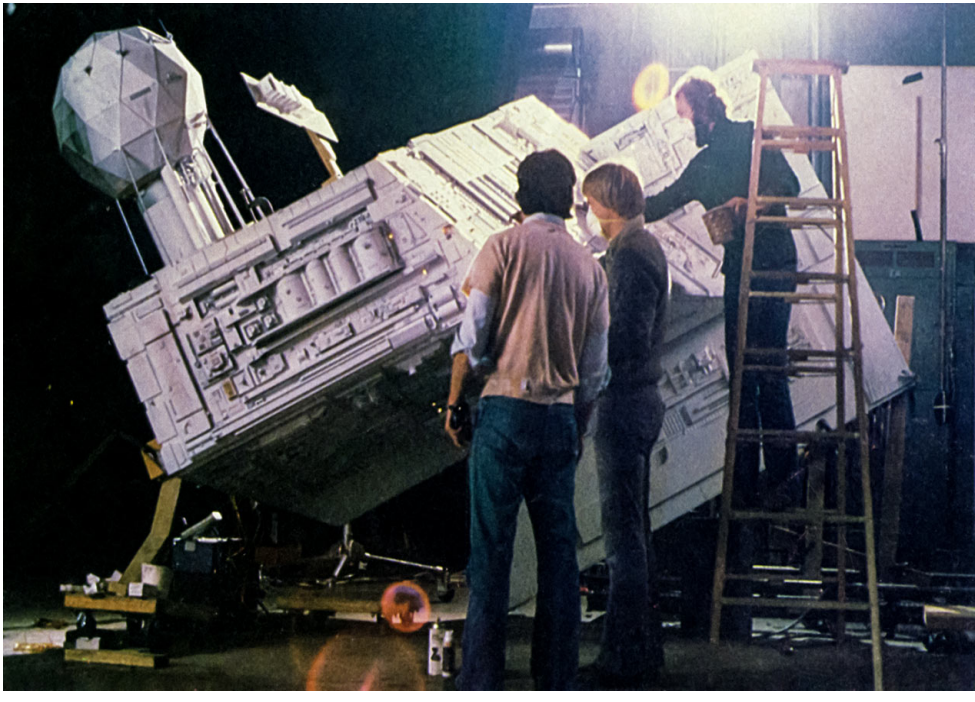
Well, what sets it apart right away is the fact that it is a beamsplitter printer with four projector heads. Most optical printers have only two. With four heads you can put a shot together in one pass. The projectors are mounted together in pairs. One pair is mounted in line with the camera; the other is mounted perpendicular. The images from both pairs are combined in a beamsplitter and photographed in the camera. So you can put your foreground and its matte in one leg, the background and its matte in the other, position the mattes until they fit properly,

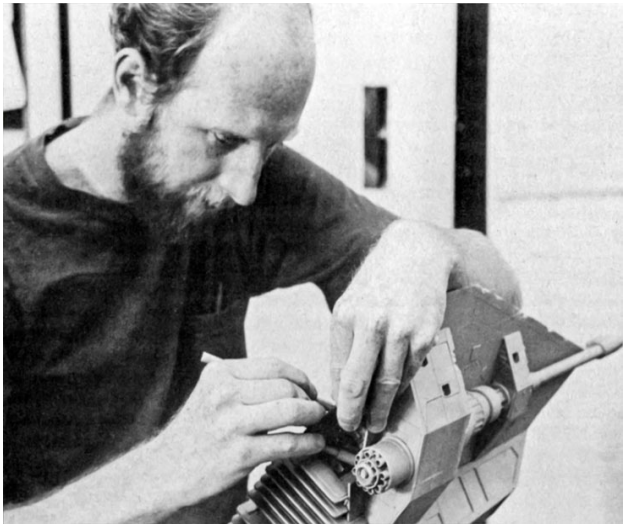


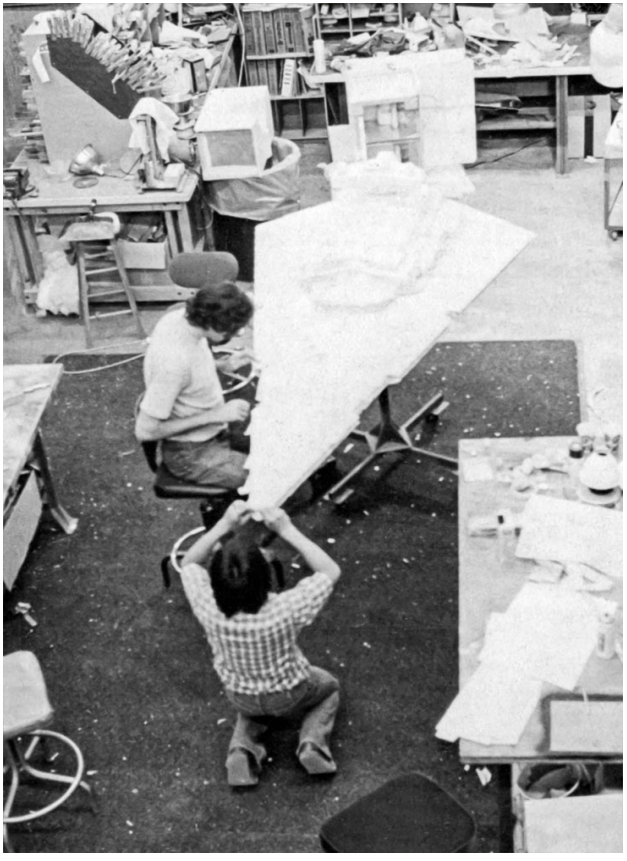


Richard Edlund examines the rebel cruiser model while executive producer George Lucas visualizes a potential camera angle. Although Lucas deferred directorial chores on his sequel to Irvin Kerschner, he remained intimately involved in the production — paying particular attention to the activities at ILM. / Effects unit art director Joe Johnston prepares a model nebula for photography. The swirling star formation was filmed with a slight rotation and incorporated into the final sequence. / The skeletal form of Darth Vader's personal star destroyer is fitted with neon tubing by model maker Charles Bailey. On camera, the eight-foot vessel dwarfed all others in the Imperial fleet. / Toxic materials are commonplace in miniature work, necessitating protective gear which transforms the model shop into something resembling a surrealistic operating room. / Assistant cameraman Rich Fichter watches as Scott Marshall and model supervisor Lorne Peterson add finishing touches on an oversize section of a star destroyer conning tower to which the Millennium Falcon *affixes itself.*









and then put the shot together in a single pass. That's one advantage. Another is that it increases the throughput of the machine — even if you use only one leg at a time — because you can be printing on one leg while you're putting up another element in the other. Obviously, that gave us more printer time, which therefore allowed us to put more shots together in the time we had. Every shot you see in *The Empire Strikes Back* that was done at Industrial Light and Magic went through that printer.

But what's *really* significant about that machine is the optics. Generally, the optical system on an aerial printer is sort of resolution-limited. In other words, what you put in the far head is not as sharp as what you put in the front head because of the limitations of the general optical system. Our printer has a specially designed optical system which is so sharp that you can use either head without worrying about any image degradation. Therefore our mattes are not distorted by the inadequate optical path which until now has been industry standard. The standard optical printer does not use telecentric lenses. A telecentric lens emits parallel bundles of light. If your lens is not telecentric, in order to maintain equal illumination across the image you have to recollect the light by means of a field lens near the image. You may have a relay lens which is capable of a hundred and fifty line-pairs per millimeter, but when you put a field lens in there you lose about half that resolution and you also introduce chromatic and geometrical distortions. But since you *must* have that field lens in there to collect the light again, you're caught between the devil and the deep blue sea. So when we set about building our own printer, we decided the best way to do it was to design the lenses first, because in the final analysis it's the optical properties of the printer that are the most important. Once we had the optical system, we could wrap the rest of the printer around it.

I had to stick my neck out a long way because it was a prototype and was going to cost a half million dollars or more, but I was convinced that we needed it in order to put the picture together and it would be something we could use for many years to come; so it was a capital investment. It finally took us about a year to build it, but it worked amazingly well right from the start — the optical system exceeded even my expectations. In fact, in quite a few of the shots we had to actually degrade the composite image in order for it to fit in properly with the background photography. So that printer was certainly a major contribution to the film, and it's the only one of its kind in the world.

Would you say that the singular lack of matte lines in The Empire Strikes Back *was a function of this new printer?*

That and a number of other things. The fact that we have distortion-free relay optics so that the mattes can fit the object perfectly is certainly a factor. But generating those mattes is another matter in itself, and we have become extremely proficient with bluescreen. The original idea on *Star Wars* was to shoot everything front- and back-lit since the motion control cameras were capable of doing an identical double pass. But I

Paul Huston and Ease Owyeung add detailing to Darth Vader's flagship. / The three-and-a-half foot diameter Millennium Falcon *used in* Star Wars *was replaced to a large extent by a smaller, two-foot version that was substantially lighter in weight and more maneuverable. Mike Fulmer adds airbrush detail to the new spacecraft. / Phil Tippet meticulously animates a miniature tauntaun and correspondingly-scaled Luke Skywalker for the opening sequence in the film. Foreground miniatures and background paintings were used for most of the stop-action shots, which were then intercut with footage employing live actors and a full-scale mechanical tauntaun. / Model shop foreman Steve Gawley works on the rebel snowspeeder — a small, two-man craft used on the ice planet, Hoth. / An Imperial star destroyer under construction.*

didn't believe that was feasible because you can't do a double-pass matte and get the leading edge of a moving object to have the same transparency as the trailing edge. It would work out okay if everything you were shooting was moving slowly against a star background, but if you get into a situation where you have a lot of blur — and there was necessarily going to be a lot of blur in *Star Wars,* because there was a lot of fast action — it's an entirely different matter. When you look at a single frame of movie film, it's surprising to see how much blur there is in it, especially when there's something traveling right towards you and it's filling the frame. I mean, the last few frames of that image are nothing *but* a blur, and the fact that they are means that they have a certain amount of transparency. If you have a shot with an enormous amount of blur, and you extract a high-contrast matte from that shot — which is what you do with the double-pass method — the matte has a very limited gray scale and you end up with an opaque matte. As a result, your images do not have that transparency that makes them look real, and they tend to strobe. So I was extremely adamant that we go to bluescreen.

The fact that we did, though, was really quite an act of faith on George Lucas' part. Like all of us, he had seen a number of bluescreen shots with enormous ugly blue fringe matte lines around them, and to him that was representative of the system. And for a director to go to dailies and see his actors working in front of nothing but this totally unusable blue background is enough to induce acute states of paranoia — especially since, at the time none of us had much of a track record to fall back on. Now, I would be the last one to maintain that the bluescreen work in *Star Wars* was perfect. In fact, there are a lot of shots in *Star Wars* that make me cringe now. But we got away with it because they were all going by so fast. Very few of those shots lasted more than seventy-five frames, and a lot of them were less than twenty-four. Since then, we've been able to develop a lot more finesse. We wouldn't have been able to do a lot of the shots we had to do in *Empire* back during *Star Wars,* particularly all the matting we did over the snow battle scenes. In fact, in general terms, I'd say the composites in this picture were several orders of magnitude more difficult than the ones we had on the last picture.

You only matted over light areas in a couple of places in Star Wars *— one where the* Millennium Falcon *is fleeing the Mos Eisley spaceport and another where you had an X-wing flying in over the jungle at the end. Matte lines were pretty evident in both of those shots. What enabled you to matte over white areas so well in* The Empire Strikes Back? *Was it strictly improved proficiency and the new printer, or did you make technological improvements in the bluescreen process as well?*

We used basically the same system. For *Star Wars* we developed a fluorescent bluescreen that functioned on direct current rather than alternating. Therefore we could do high-speed photography without worrying about flicker problems. I believe it was the first fluorescent bluescreen. I may be wrong there — I've met five guys who've all told me they invented the blimp — but it was certainly the first large-scale bluescreen done with direct current fluorescent bulbs. We made refinements on it for *Empire,* so we've now got a better blue; but it's basically about the same. The system for mounting the ship was something I developed back on *Star Wars.* We use a neon pylon which is color-balanced to the bluescreen so we can eliminate the need for rotoscoping the mounting rods out of the shot. We refined that a bit, too; but not much. I think we really hit on the simplest possible shape and the simplest possible technique for doing that in *Star Wars;* and to me, the simplest answer is generally the best. It's easier, it seems, to make things complicated than it is to make them simple.

Did you make any significant advances in motion control technology over what you had used in Star Wars?

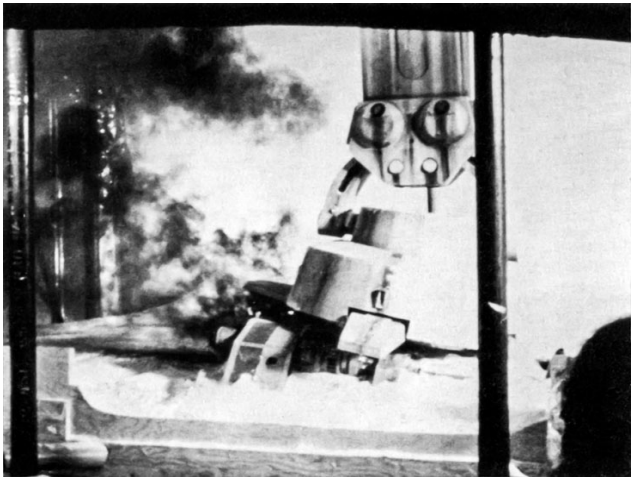
Yes. Even though the system we used on *Star Wars* was quite fine — and functioned well with a few modifications even on this project — we have a new system with capabilities that far exceed the old one. Our basic philosophy of miniature preprogrammed photography is based on the concept that in real photographic situations, especially in battle circumstances, your camera movements are bound to have a certain amount of random motion. Therefore, in order to duplicate the feeling that what you're seeing is being photographed on-the-spot by a human and not by a machine, we program most of our camera moves manually with a joystick device. If you were to have an absolutely perfect move, it would have none of the irregularities that are characteristic of human action and it would really be rather an uninteresting shot. However, there *are* situations where a computer-generated, mathematically-perfect move is useful — like with titles or with a really short cut where it doesn't matter that it looks that way — and our system now has the capability of graphically plotting out each axis and doing that. So even though it's something that we don't use all the time, it does have its applications; and if we can aid the speed of production by utilizing the technique we'll do it. More often than not, though, it takes longer to produce a program mathematically than it does to actually go out there on the stage and turn knobs and screw around until it looks right. But the capability is there when we need it.

We also built a field-usable motion control system — with a reflex VistaVision camera, a special Mitchell gear head, and a tape data storage recorder — that you can use out on location to record pans and tilts and then repeat them later back on the stage.

Is this like the system used on Close Encounters *which allowed them to make camera moves on live actors and model saucers in the same scene?*

This one's basically the same, but more streamlined. As it turned out, though, we weren't able to use it on the live-action footage, because it wasn't ready by the time the unit went on location. We'd already designed and built the camera for the unit — and that was shipped to Norway for use on the live-action shots we'd later be matting on — but the field recorder system was not complete at that point. After the location work was

A major effects sequence on Hoth involved an attack on the rebel stronghold by five Imperial walking machines. Most of the walker footage employed three eighteen-inch models which were stop-motion animated by Phil Tippet and Jon Berg. A couple of shots, however, required walkers to fall over, and for these, a larger, four-foot model was constructed and filmed with a custom high-speed camera to maintain a sense of mass as the walkers collapsed. While Richard Edlund waits behind the camera, stage technician Ed Hirsch adjusts a breakaway wire rig and Jon Berg positions the feet. Model shop foreman Steve Gawley assists. Surgical masks were worn to avoid inhaling the baking soda which doubled as snow.



finished, the camera came back to our facility and Dennis used it to shoot just about all of the miniature stop-motion material.

All together, we had four motion control systems in use on *Empire*. We also had a matte department that we built up from scratch, a custom-built VistaVision-format Oxberry animation stand, a rotoscope camera, a garbage matte camera, and a half dozen or so other cameras. By the time we were in full swing, our once-empty facility was filled to capacity with all sorts of equipment and we had a crew of about ninety people.

The opening shot in Star Wars *was a real grabber. Did you make an effort to duplicate its impact in* The Empire Strikes Back?

Empire was going to open in the snow at first, but then somewhere along the way George decided he would rather have it start out in space. Certainly, the opening shot in this picture isn't as dynamic as the one in the original — but then it didn't need to be, really. The philosophy on the *Star Wars* shot was that this was going to be the first impression you were going to get of the picture. The effects were obviously going to be very much different from anything that had gone before. They were certainly a *lot* different from *2001*, for example, where the effects shots were very ponderous and were on the screen for huge chunks of time and were done with enormous miniatures that took up entire sound stages. Well, we didn't have the luxury of being able to work that way. We had 365 shots to do and not a whole lot of time or money to spend on them. So instead of having miniatures that were fifty feet long, we had miniatures that were eighteen *inches* long, and we used speed to achieve our effect. That was kind of our style. I'm not sure if it was realistic or not, but it was stylistically integral — and it was convincing enough to prompt an astronaut that I met at a party once to tell me that he believed it all and was glued to his seat. An any rate, we wanted the opening shot in *Star Wars* to be so amazing that people would say: "My God! Look, it's still coming! It's enormous!" We wanted that first impression to be a positive one — one of awe — so everyone would immediately be satisfied with the look of the effects and the style of the effects and would then sit back and say: "Well, I've accepted that. Now, let's get on with the story." We didn't have to concern ourselves with that going into the second one.

The film has some really innovative stop-motion work. Could you discuss the helicopter shot that swoops in over the running tauntaun?

That was Dennis Muren's *piece de resistance*; and I think it's one of the best shots in the picture from the standpoint of ingenuity. It was very well planned and very carefully executed, and a great deal of time went into it. The basic helicopter footage was shot with a Wesscam system, which is a special camera system that hangs off of a fancy helicopter and is gyrostabilized to take bounce and roll out of the picture. For that particular shot, it was gyrostabilized on two axes to stabilize the horizontal and the roll. The tilt was joysticked, so that as you flew into the shot you could tilt down onto a particular area. Once we had that footage, it was a matter of plotting points. Basically, you have to take features on the ground — and here there weren't very many — and then see how they change. There was a rock in the middle of the shot which was an important point, and there were certain ripples in the snow you could pick out if you got good at it. From those, we had to work out the geometry of what the actual move was, and then plot that on the Oxberry to find out just how far the camera moved in and how much it tilted — within pretty exact tolerances. It's like photo interpretation — plotting an airstrip that somebody shot flying over Cambodia, or something. Once we isolated that information, Dennis had to program the motion control system to reproduce — on the tauntaun — the exact amount of angular change that was going on during that helicopter shot. The tauntaun, meanwhile, had to be moving horizontally through the frame at a certain speed. Phil Tippet did that with stop-motion animation. Once the tauntaun was photographed with all the proper moves, Sam Comstock had to rephotograph it on the Oxberry and reduce the image down to the right size to fit the scene. Then, in addition to the basic elements, there were other things to contend with — like shadows under the tauntaun and, of course, mattes. So what you end up with is an extremely complex series of events, all of which have to be done just right, and there's no real way of telling if it's going to work until you see it all composited. So it was quite an accomplishment.

When you're working on a film like this, do you find yourself grading potential shots — either by degree of difficulty or importance — and then devoting your energy to them on some kind of a prioritized basis?

Well, certain shots you *have* to concentrate on more than others — that's just part of understanding the momentum of making a feature film. At the beginning of any project, you read the script and then you begin making storyboards. But while you're in the process of making your storyboards, you have to bear in mind that what you're coming up with has to be done, and it has to be done by one or more people using certain techniques and with certain equipment which is either available or under development. So it's a very complex matrix of actions, all of which have to be coordinated. Jim Bloom, who was the associate producer on the picture, was basically responsible for coordinating all of the activities at ILM. He set up the location shoot in Norway; but then when that was finished and the production moved on to England, he came back here and helped us by developing a production board and scheduling out all the shots.

I remember Lin Dunn coming out to ILM during the early days of *Star Wars*. He was there at the behest of 20th Century-Fox to sort of look us over, because nobody there really knew who we were or what we could do and they were banking on us to complete this multimillion dollar picture. Anyway, Fox wanted some learned opinion, so they sent out Lin Dunn and Cecil Love — beloved deans of special effects — to look us over. And I remember Lin's very adamant advice: "I have no doubt that you guys can do the work, but what you *really* need here is somebody to help you schedule." So, yes, you have to prioritize and you

The large-scale walker was used once again for an explosion shot triggered by Luke's tossing a detonating device inside the lumbering war machine. That explosion, and a subsequent larger one after the walker collapses, were also shot at high-speed. / Joe Johnston adds painted highlights to an oversize walker foot. / The oversize foot was mounted on a giant pipe rig and used to crush Luke's downed speeder.

have to keep evaluating things and making changes where necessary. And you have to know up front if some idea you have is going to take a long time to develop and execute. Like the walkers, for instance. I mean, never before had that kind of effort gone into a single stop-action sequence. We had several guys who worked for damn near a year on that — designing those things, building five or six of them, and then getting them all tweaked out and detailed. Then shooting them took maybe another two months.

Could you discuss that sequence a bit?

Dennis Muren did most of the photography — in fact, I think he did all of it except for the high-speed work which I shot. Jon Berg and Phil Tippet animated the snow walkers. As far as the stop-motion goes, Jon was chiefly involved in the design and animation of the walkers — although Phil did some of that animation as well — and Phil was chiefly responsible for the tauntaun. The walker sequence involved several different filming techniques. A large amount of it was shot using foreground miniature landscapes and painted backgrounds. We used about fifteen different background paintings in the walker sequence and the tauntaun shots. The largest was about thirty-five feet wide and twelve feet high, and the smallest was maybe four feet wide and two feet high. The walkers themselves were about a foot-and-a-half tall. The speeders flying around them were shot separately under motion control and matted in.

One of the shots that worked out rather nicely, I thought, is the one where Luke's speeder crashes into the snow. In the initial part of that scene — a POV shot out of the cockpit window — the speeder goes flying past one walker and then dives down almost to the point of impact, which is practically under the feet of one of the other walkers. What we wanted was to hold the shot all the way until the speeder actually hit the ground and then have snow flying up over the canopy. Well, that would be impossible to shoot in a stop-motion situation; so we did the shot in stop-motion all the way down until just before impact. Then we had our expert grip build a little luge rig for the camera. We called it that because the Olympic luge competition was going on at that time. It was sort of a sled with a plexiglass shield shaped like the speeder canopy, positioned in front of the camera. Then, with the camera at Luke's point of view, we smashed the whole rig into the snow. We used about thirty or forty frames of it, and we made a direct cut from the stop-motion footage to the luge so it looks like one continuous shot. The speeder goes in and snow flies up over the windshield. And it works, because you're not jarred by the cut at all. You're so caught up in Luke's situation that you don't even notice it.

That sounds somewhat similar to the point-of-view shot you did in Star Wars *where you cut from a still photograph to live action as you come in over the Death Star and swoop down into the trench.*

Right. I think that was a real successful shot, too. In fact, it's one of my favorite shots in *Star Wars* and one that drew some of our nicest compliments. The whole idea is to create an impression. You have to design and execute your shots in such a way that your audience is swept along by the action and the drama and not disturbed by a flaw in the special effects. If you've done that, then you have a successful shot.

One of our most complex shots in the walker sequence was done with bluescreen matting — we had to use that technique whenever we had people composited into the scenes. This one particular shot showed a bunch of the rebel troops running toward the camera, retreating from the walkers which you can see approaching in the background. We started out with a plate shot on location in Norway that had the foreground action of the guys running forward. We took that, put it on a viewer, and made an exact tracing of the shot. From that, we could determine precisely at what angle the camera had been shooting and then duplicate that angle when we shot the miniature walkers. Once we had the proper perspective and the proper lenses and everything on the camera, we went ahead and shot the walkers — I think there were two of them — against bluescreen, and then matted them into the live photography. The only area that was problematic was how to make the feet look as though they were actually touching the ground. Obviously, if it doesn't look like these things are standing on the ground, your shot has failed. So Pete Kuran did what we call a grounding matte, which matched the two elements so the walkers' feet looked like they were indeed hitting the ground. Then, of course, we had speeders flying through and animated lasers zapping back and forth. So by the time we got all the elements for that shot and it went through editorial and optical, nearly every department at ILM had a hand in it.

Then there was an explosion that was done live on location with all kinds of debris and stuff flying about, and what we did was we matched a speeder's trajectory towards the spot where the explosion was going to occur and timed it so it would look as though the speeder went crashing into the ground and blew up.

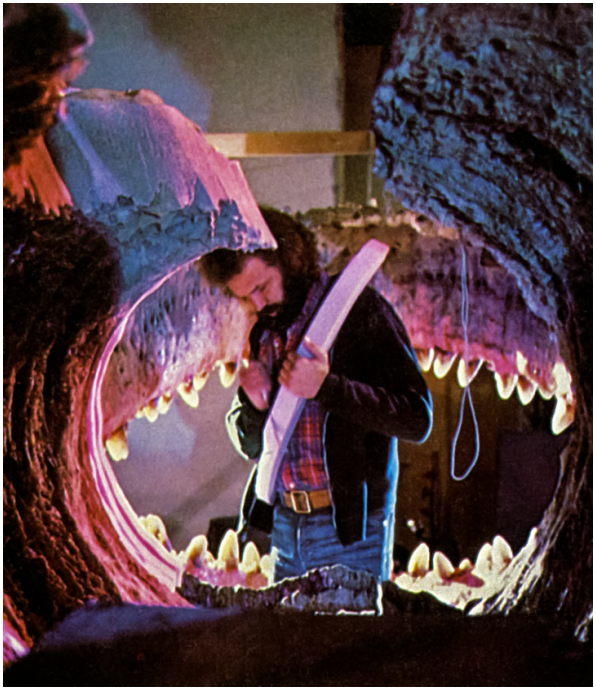
How about your high-speed work in that sequence?

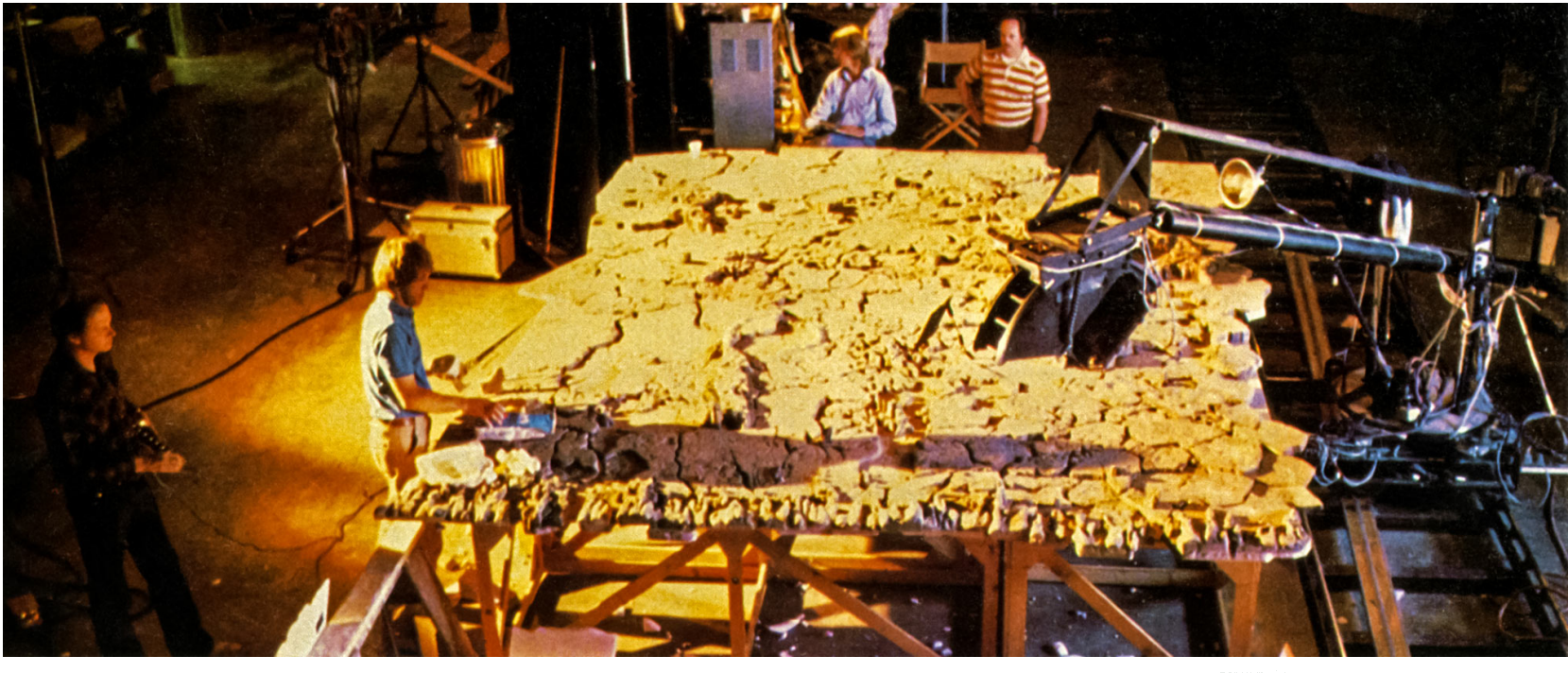
We used high-speed photography in several places where we had to convey an impression of great mass — for example, in the scenes where the walkers are toppling over. For those shots, we built a larger scale model of the walker, about four feet tall. Jon Berg and Tom St. Armand did a wonderful job on that, getting this enormous thing machined and built and ready to behave properly once the camera was rolling.

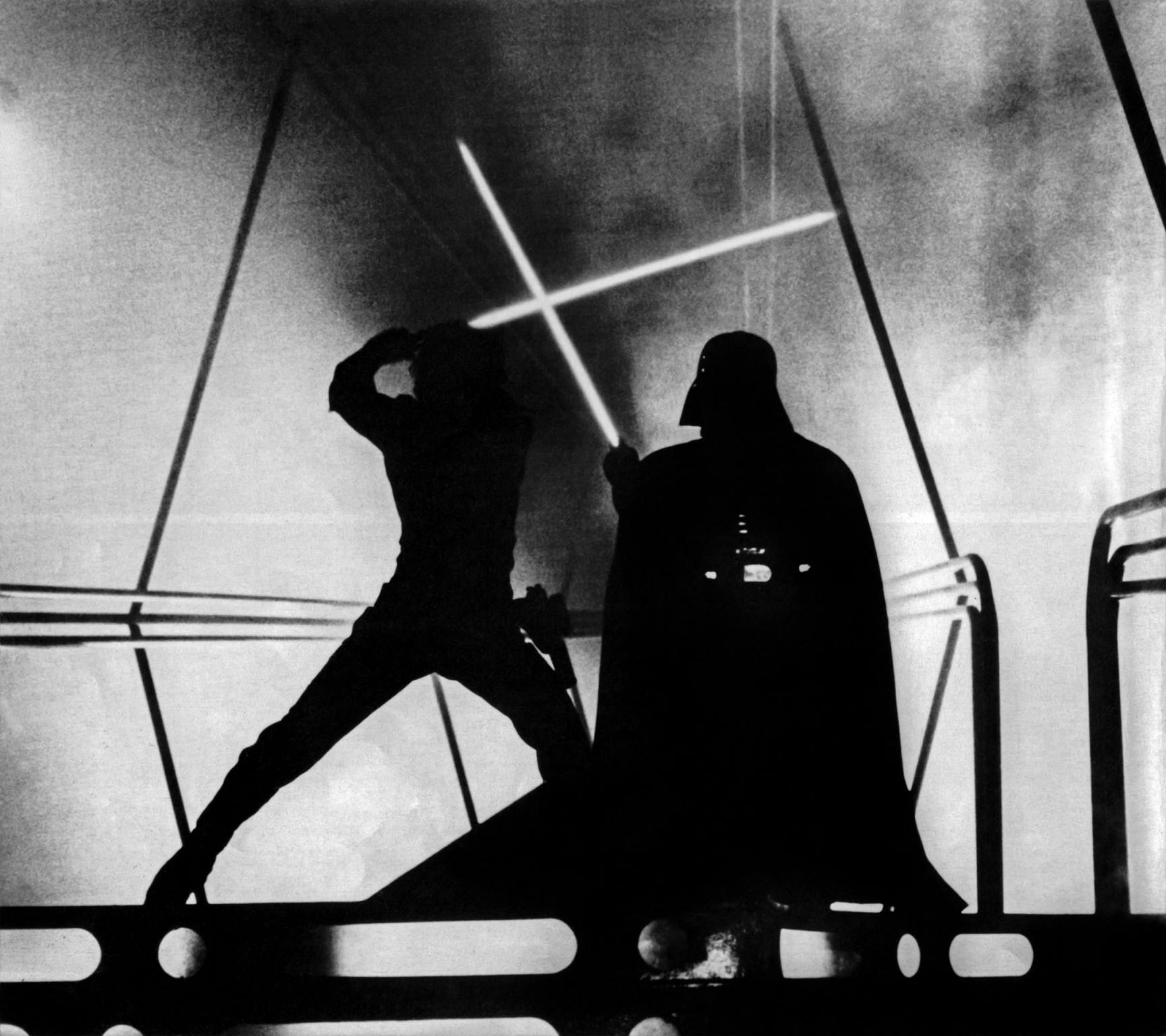
Was that model electronically operated?

No, it was all done by hidden wires and solenoids and getting the thing properly balanced so it would topple over just the way we wanted it to. The high-speed camera, though, wasn't ready until just about the time we were starting to shoot that stuff. When the movement was delivered to us it would run all right, but not at the speeds we needed — so we had to do a considerable amount of massaging. Making a camera movement go fast is just one of those things that I guess you could call a black art, because it's something that can't be readily taught. You have to learn from experience and fooling around and making mistakes. So it was a very complex and tedious process, and by

The Millennium Falcon's *pursuit through an asteroid field was punctuated by a daring dive into a giant cavern which turns out to be the interior of a monstrous space slug. Lorne Peterson works on the mechanized jaw segment which begins to close just as the miniscule* Falcon *attempts its escape. / Earlier in the sequence, the ship makes a daredevil barnstorming run through the asteroid's treacherous chasms. Effects director of photography Dennis Muren films one segment of the dizzying passage. A layer of smoke in front of the camera serves as a diffusing agent. / Dennis Muren (left) prepares a motion control shot from the* Millennium Falcon's *point of view as it skims the asteroid's cratered surface.*







the time we got the camera up to a speed we could get by with, we already had stuff waiting to be shot. There are formulas for sort of figuring out how fast a camera should run on high-speed shots, but normally I just go by what I've done in the past and what I think ought to work. Most of the high-speed stuff in *Empire* was shot at ninety-six frames per second because that was about all we could coax out of the system — we're reworking it now and I hope eventually to get it up to a hundred and fifty.

Anyway, the walker sequences were done stop-action with the smaller models, right up until the time they start to fall over — then we cut to the high-speed work. It involved a lot of very skillful manipulation to get them to topple over, and for the one shot where the thing gets roped by one of the speeders, we did about four or five high-speed takes with wind machines going and everything. And we got some pretty interesting variations. I think the one we finally used — where it kind of kicks up its heels and falls over sideways — is pretty funny, and I guess audiences like it because they always give it a good reaction. The other walker — the one that tumbles forward on its face and blows up — I shot with my own personal camera, which is a high-speed Mitchell that'll run at 175 frames per second. It's not VistaVision, though, so that one shot had to be anamorphic. But in this particular case, it was more important to have the speed than the image area because in order to get the pyrotechnics to look in scale you have to shoot them as fast as possible.

A majority of the high-speed shots were done with the painted backdrops, but we did do a few with bluescreen — for example, the shots where Luke shoots his magnetic line up onto the underbelly of one of the walkers and shimmies up. That was done high-speed in order to give the feet the apparent weight they should have. Another shot we did high-speed was the one where Luke's speeder gets crushed. For that, we had one large foot mounted on an enormous pipe rig that was built out of camera range; and we used a special model speeder made out of thin metal. An awful lot of work went into making that thing and detailing it out — so it was a one-shot deal. If you blow a take like that, the model makers aren't real happy.

Did you do high-speed work anywhere else in the picture?

Yeah, we did the space slug in high-speed — that big thing that comes out of the hole in the asteroid and snaps at the *Falcon*. Also a lot of explosions. For those we rented the San Francisco Armory, which is an enormous drill hall over in the Mission district. We picked it because it was the biggest single room we could find anywhere that was unrestricted — the ceiling's a good eighty feet high. We constructed our own ceiling in there that was black and measured about a hundred feet long by sixty feet wide, and we photographed a whole bunch of explosions, about sixty feet off the ground, that were really quite large. We had five high-speed cameras going on each take, and we only had one jam on us in all that time. There were two VistaVision high-speed cameras — my old favorite that I used to rent from Paramount that maxed out at seventy-two frames per second, and our new one that was shooting ninety-six. We also had three others shooting anamorphic, including Bruce Hill's high-speed camera that runs 360 frames per second. As a result, we have about the best library of explosions you could possibly imagine. We filmed in there for a couple of weeks and ended up with something like four hundred different explosion shots.

Then you just superimposed those explosions over whatever it was you wanted to blow up?

Well, we extracted mattes from them first; but basically, yes. There are a number of them in the asteroid sequence, and a couple that characterized the generator blowing up that are just seen through windows. We also had two shots of speeders blowing up that were wire explosions. And I think we had one or two where we used another trick of losing the ship with some help from the animation department in the last few frames, just to sweeten the shot.

When you have shots which are just incredibly intricate and complex — like a number of the ones where the Millennium Falcon *is being chased through the asteroid belt — how do you go about first conceptualizing and then executing something like that?*

It's a building process. One of the key shots in that sequence featured the *Falcon* wheeling its way through this field of flying rocks; and in order to pay off on the idea that they have a real rough row to hoe, we wanted to have one of the TIE ships that's following it crash into an asteroid. So there's a lot of activity going on, and each of the elements — including the separate pieces of rock — all needed to be shot individually. Normally you start by programming out the most important compositional element in the shot first, which in this case happened to be the largest asteroid. So we shot that, and then we went to the *Millennium Falcon* swerving around it — knowing that at a later time the animation department would put a shadow across the surface of the rock to tie it all in together. Then came the TIEs. The TIE ships are all pretty much anonymous, but nevertheless they're there, so once we had the rock and the *Falcon* flying by it, we programmed and shot each of the TIEs separately. So we had the first TIE flying through, the second TIE flying through, and the third TIE flying through. But at this point in the composition we wanted the third TIE to collide with an asteroid, so we then programmed in the rock that the third TIE would collide with and flew it into the scene. As each individual element is programmed, we shoot a black-and-white test that we can process right on the spot to preview the move. Since it's negative film stock, the image is positioned against a clear background. Therefore we can multipack up to six or eight of these tests in a custom viewer and check all the elements at once to make sure everything's fitting together right. Assuming it is, we can then start filling in the composition. In this case, we added quite a few more rocks to make the asteroid field look really dense. Then, to make it even more precarious-looking, we had some of the rocks flying in one direction and some in another. Then there were three background paintings of more rocks that were filmed with a multiplane technique — and of course a star field. So by the

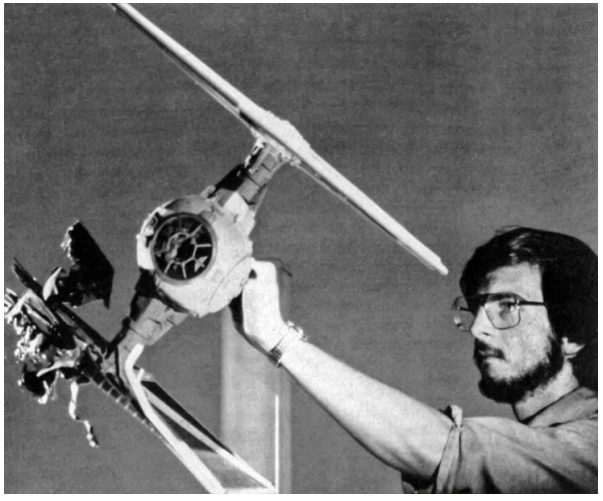
Edited footage from the lightsaber duel between Luke and Darth Vader was turned over to the ILM animation department where it was projected a frame at a time so that animators could airbrush cel overlays of the shimmering blades. The painstaking task was complicated by the fact that the actual swords used by the actors frequently disappeared in a blur when swung through the scene. The cels were later photographed on a custom animation stand and superimposed back in over the stage photography.

time you've shot four ships, ten or twelve separate rock elements, three background paintings, a star field, plus miscellaneous explosions and shadows and lasers, you wind up with maybe twenty-five separately photographed pieces of film each of which has to be broken down into color separations and each of which has to have all the intermediate bluescreen steps to extract mattes. So all together, you have maybe a hundred and twenty pieces of film involved. And I'll tell you, the poor guy who runs the optical printer has really got to love his work, because he has to put it all together and make sure the color balance is just right and all the matte lines are gone. That particular shot had to be put together about four times to get it just perfect.

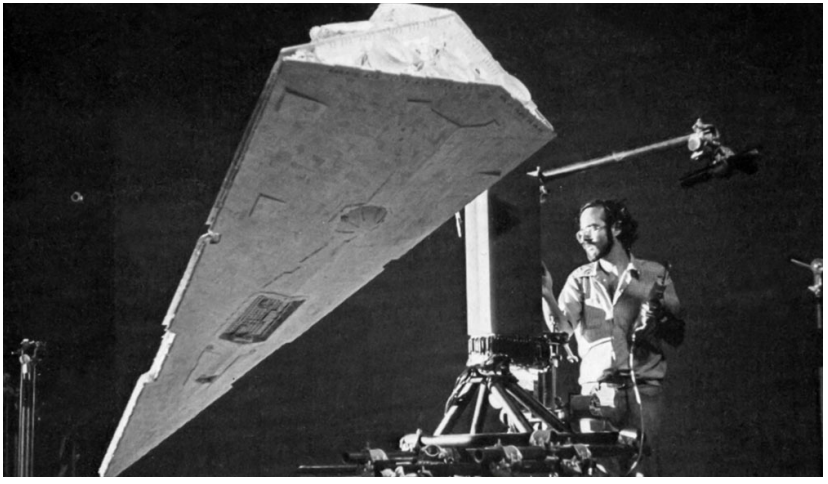
In Star Wars, *George Lucas cut together a reel of World War II flying footage as a prototype for the final dogfight. Did you do anything comparable to this for some of your more complex sequences in* The Empire Strikes Back?

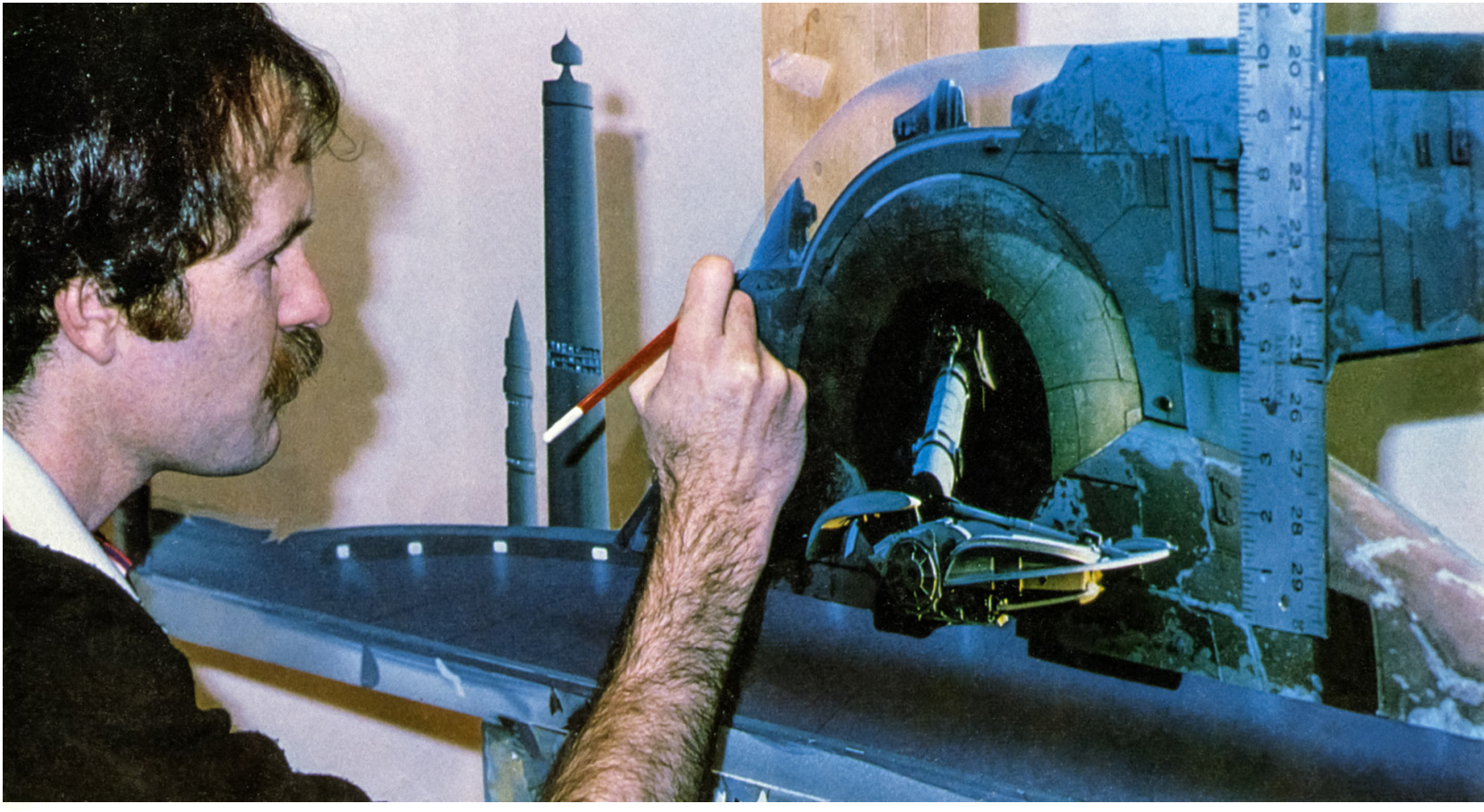
As a matter of fact we did, but this time we used some rough animation instead of live-action — kind of like moving storyboards. When you're in a situation where you have literally hundreds of shots to deal with, it's extremely important that you get as much of the arbitrarity out of it as possible so you can actually understand what it is you're supposed to be doing. It's not enough to think of a shot in terms of ships flying through in one way or another. If you understand it only to that extent, you may end up with some very nice shots, but you're going to have a second-rate sequence. In order to make a first-rate effects sequence, you have to understand how the sequence flows, and how each shot interacts with the ones around it. In the case of George's much-heralded 16mm dogfight film, what he was trying to do was show what he had in mind in terms of dynamics — to show that when one pilot turned his head and his eyes darted to the right, then the next shot you cut in there ought to have a continuity of action. It wasn't just a matter of flying these ships through a shot here and there. Everything had to be integrated, and everything had to serve some kind of dramatic function. So anything you can do that will provide a point of departure for discussion, and provide some overall understanding of what's going on for the guys who are actually out there doing the work, is wonderful — even if it's just funky animation done with storyboards and a few cels. It gives you a frame of reference. But it was only an organizational tool. It's not as though we drew out the sequences and then shot them *exactly* that way — there was a lot of room for interpretation. Also, it's a great help in cutting the picture, because there's nothing worse than watching a picture and then suddenly there's a black slug in there that says "scene missing" — it completely disrupts your editorial train of thought. So with these animatics, at least you have *something* to put in there, even if it's just simple cartoons or World War II planes flying through a space movie — at least you still have the dynamics.

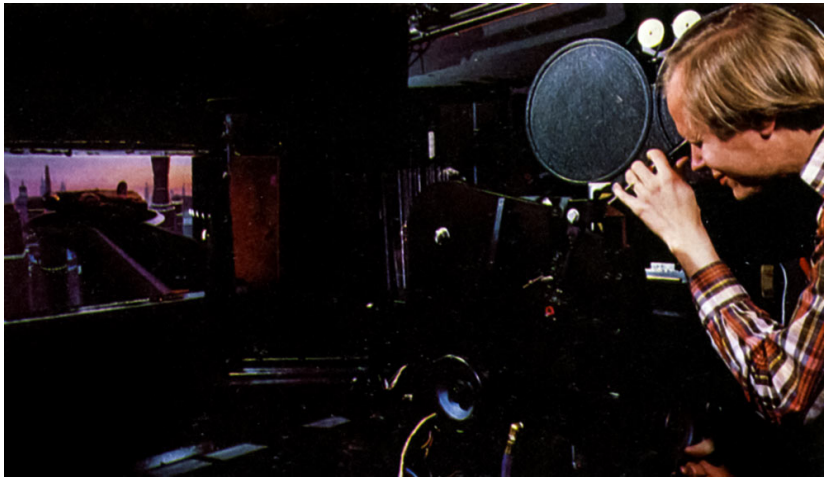
Let me ask you something. Was there anything in the picture that you didn't buy because of the effects?



Effects cameraman Ken Ralston aligns a battle-damaged TIE fighter in preparation for a bluescreen matte shot. / Model maker Tom Rudduck examines a pair of cloud cars sent out to intercept the Millennium Falcon *as it nears the floating city of Bespin. / Special projects coordinator Stuart Ziff prepares for a shot featuring the Imperial star destroyer. The eight-foot vessel, mounted on a rotating model articulator, replaced the three-foot version used in* Star Wars. */ An exotic rebel cruiser provides sanctuary for Luke and Leia at the close of the film. / Matte painting supervisor Harrison Ellenshaw at work on a painted representation of bounty hunter Boba Fett's ship, at rest on the Bespin landing platform. Ellenshaw — who had been previously committed to* The Black Hole *— joined the ILM unit in the latter stages of the postproduction effects effort. In only six months, he supervised the preparation and photography of nearly fifty matte paintings.*







Not very much. There were a few shots in there where you could see through some of the ships.

Ah, you noticed those. I noticed a couple, too — to my dismay. That's a result of transparency in the mattes. If your matte is even a fourth of a stop too thin you're going to have that problem, and I guess a few of those slipped by. I don't mean to suggest that nobody noticed, but when you consider that we had something like 440 shots to do, it's not always possible to perfect every one of them a hundred percent — there just isn't time. We worked our way through the production schedule, and as we completed shots some of them would be perfect, others had to be redone, and others yet went onto a "could-be-better" list that included all the shots we could probably get by with if we had to. Then we developed priorities within that list, and as time permitted we'd rework them. Unfortunately, there just wasn't enough time to go back in and fix all of them.

Another thing — I thought the matte paintings used in the cloud city sequence were fairly obvious.

I think one of the problems you have with any "city of the future" idea is that your audience knows it has to be something like a matte painting or a miniature, because it couldn't possibly be anything else. If you do a matte painting of a castle on a hill, then most people are going to accept it because they know a lot of castles have indeed been built on hills. On the other hand, if you see this huge city shape perched on top of a golf tee hanging in the clouds, you *know* that it has to be some kind of a miniature or a painting. So right off the bat, you're starting out with a real heavy strike against you in terms of truly convincing anyone that it's there.

Frankly, I think that whole sequence would have been helped by having a very large, detailed miniature of the city, but we just didn't have time. As it was, we built at *least* fifty miniatures for this picture, including a lot of new spaceships. We had Darth Vader's executor star destroyer, the speeders, transports, and number of others. The ship that Luke and Leia are featured in at the end was an *enormous* project that was added late in the picture. And it was a fairly complex model that we had to set up so we could do projections into it and so on. So even though, in terms of motion pictures, we may be the closest thing to having what might appear to be NASA-type funding, we really don't. We're very frugal with our expenditures and we do our best to bring the picture in for a reasonable sum. And I think we did bring it in for a reasonable sum — especially in comparison to some other recent films where the effects work has cost *astronomical* amounts of money. So at any rate, we decided on a matte painting for the cloud city. Ralph McQuarrie did it and it's a very nice painting, but I'll agree with you — offering the above excuse — that the illusion is not quite perfect.

We have a lot of painting that work very nicely though, I think. My favorite is one on Yoda's planet where Luke's X-wing is in the bog and there's some smoke coming out of it and a couple of birds flying through the scene. Harrison Ellenshaw did that one, and it's all painting except for a little foreground water with some fog. All we added was the smoke coming out of the X-wing, and the birds which were animated. There were some other good paintings as well — several in the area where Darth and Luke were fighting. Another one actually featured Joe Johnston, the art director for our effects facility, Ralph McQuarrie, Harrison Ellenshaw, and Mike Kelly of the editorial department. That was shot in the hangar when they're taking off. We dressed those guys up in costume and shot the matte painting behind them with bluescreen. Ralph did that particular painting, so it was kind of neat to have the guy who actually did the painting moving around in front of his own artwork.

What kind of a matting system did you use for your paintings?

We used a front projection system on *Empire*, although we're now building a rear projection system that I think will be the ultimate matte painting device since we'll be able to fly the matte camera using motion control. Anyway, with the front projection system, you do your paintings on glass and leave holes wherever the live-action elements need to go. Then you just put Scotchlite front-projection material directly behind the holes and project your action onto it through a front projection beamsplitter. It's a nice quick method for doing certain kinds of matte paintings.

On Star Wars, *the lightsaber duel between Darth Vader and Obi-wan Kenobi was shot on the stage using swords covered with that same kind of highly-reflective front projection material. The process wasn't totally successful, though, so you ended up having to enhance just about all of it with animation. Was the same system used on* The Empire Strikes Back?

No, unfortunately. Since they figured it was going to be animated anyway, they didn't use the front-projection material this time. And it made it much more difficult for us, because last time — even though the effect was not totally satisfactory — at least we could always see the swords. This time, especially wherever we had a situation where they were being swung mightily through the scene, the image tended to disappear in a blur. So it was much more difficult to plot the animation.

You once rated the Star Wars *effects as being 3.5 on a scale of 10. How would you rate* The Empire Strikes Back?

Actually, I think it was George who was quoted as saying that — I just tended to agree with him. But if I had to rate *Empire*, I guess I'd have to say it broke fifty percent — maybe 6.5.

Do you think you'll make it up to 10 with Star Wars III?

No, I don't think so. One of my pet philosophies has to do with the necessity of remaining an amateur. The reason for that is my feeling that if you work real hard at something for ten years and finally decide to call yourself an expert, then the minute you do that you've locked yourself off. The idea of remaining an amateur is important, because if you are an amateur you can still be awed by something and your curiosity can still be piqued — whereas, if you're an expert, you tend to shore up your castle and sit in it. So I think the time I start thinking I'm approaching 10 on the scale is about the time I should start thinking about retirement.

Conceptual artist and design consultant Ralph McQuarrie was enlisted as a matte painter during the final months of the production, and personally executed about half of the paintings in the film. / Matte cameraman Neil Krepela shoots a McQuarrie painting of the sky city landing platform. Most of the paintings were done on glass with clear areas left open so that live-action elements could be front-projected into the scene on a separate pass. / In the final composite, only the underside of the Millennium Falcon *and the landing platform and ramp surface area are real — everything else is painted.*

GREG JEIN
MINIATURE GIANT
STOP

On August 1, 1980, Roy Neary's obsessive quest — begun nearly three years ago in *Close Encounters of the Third Kind* — was at last fulfilled. Dwarfed by the enormity of the alien mothership to which he had been inexorably drawn, Neary stood alone on a tiny notch in one small section of the vessel's vast interior. Before him loomed an almost boundless amphitheater, illuminated by thousands of distant lights randomly eclipsed by swarms of glowing saucers buzzing around a central power core. The apparent vastness of the alien craft, however, was illusory. What the awestruck Neary was actually viewing was quite simply a wood and fiberglass construct approximately fifteen feet tall and twelve feet wide — a spider's nest of fiber optics and minute plastic detail engineered by master miniature-maker Greg Jein.

Jein admits he got into show business purely by accident. While earning a degree in fine arts from Los Angeles State College, he learned the tedious and frequently uncomfortable skill of fiberglassing; and it was that ability that got him his first job. "Nobody else wanted to do it," he affirms. Working with Bill Hedge in a little effects shop in Santa Monica, Jein constructed a number of fiberglass props for the "Chicken of the Sea" show at Sea World of San Diego. Just as he was finishing, Hedge became involved in what was supposed to be a quickie porno parody of the classic *Flash Gordon* serials, and he invited Jein into the project. Both believed it would be a few weeks work at most. But in fact, it was only the first in a series of professional challenges that would lead, in what seemed one long and hectic five-year race, to Roy Neary's final entrance into the mothership.

At the time, however, Jein thought of the *Flesh Gordon* job as merely an improvement over the public relations work he had been doing since graduation from college. Working from designs provided by Mike Minor, Jein was assigned to build the sexually derivative spaceships required for the film, including Flesh's own *Flying Phallus*. The quickie project, however, ended up taking better than eighteen months, on and off. "There are horror stories I could tell you about fighting with the lawyers to get our money. There were bad checks all the time." But it was the first time Jein had worked seriously with miniatures, and the project afforded him ample opportunity to test his fledgling skills. It also provided some of his first contacts in the business — with such future notables as Dennis Muren, Jim Danforth, Rick Baker, Doug Beswick, and others who were likewise ensnared in *Flesh Gordon*.

It was rough going for them all, but the long periods of inactivity, litigation and irregular pay made Jein available for other projects as well. One of those projects paid off rather handsomely. "At one point, the *Flesh Gordon* production company went to court over another pornographic movie they made, and had to shut down for a while. So after about a week of nothing happening, Jim Danforth and Bill Taylor came to me and said that Dan O'Bannon over at USC needed some stuff for this student movie he was making with John Carpenter." The "student movie" was *Dark Star*. Jein went to see a workprint to which no special effects had yet been added, and thought: "'Hey, this is a pretty nice little film.' And since I wasn't doing anything at the time, I said, 'Sure, I'll throw my two cents in on that.'"

Dan O'Bannon gave Jein a drawing of the *Dark Star* spaceship by Ron Cobb, and told him, simply enough, to build it. Employing the same technique he had used on *Flesh Gordon*, Jein went to a Los Angeles plastics supplier and bought a block of urethane foam. Then, working in a parking lot behind the blinds and curtains shop where *Flesh Gordon* was being filmed, he took a disc sander and in one Saturday afternoon carved out the basic shape of the *Dark Star*. "First I cut out the profile, then the elevation. Then I smoothed out the sides. I gave it about fifteen coats of resin and sanded it down. It was actually a pretty easy job." At the time, Jein was hesitant to take even the slightest of liberties with an approved design. "The only thing I changed were the call letters on the ship. Originally, they were 'AEC' dash something-something-something. But when I put the letters on, it looked to me like 'Atomic Energy Commission' — and I thought that would be a little too familiar to the public, like putting 'Department of Sanitation' on the side. So I changed it to 'ADC' — 'Atomic Destruction Craft,' or something like that." Jein delivered the thirty-five inch model in about two weeks. True to Ron Cobb's design, Jein's *Dark Star* was essentially smooth-skinned; but once O'Bannon had the model in hand, he added a fair amount of surface detail using bits and pieces culled from plastic model kits. It was then used primarily for still photographs which O'Bannon cut out and animated a frame at a time.

The *Dark Star* project would eventually lead to one of Jein's major breaks, but directly after *Flesh Gordon* wrapped up he used some of his new-found contacts to land jobs at several Hollywood effects houses geared toward the production of television commercials — places like Cascade Pictures. He made miniature prop materials in great abundance during that period — items like tiny wagons and stalks of corn for the Jolly Green Giant, tiny communications satellites for the telephone company, and even miniature replicas of Sizzler Steakhouse signs to be stuck into plates of food. It was a time for learning and perfecting his skills.

"I went to a lot of science fiction conventions in the mid-Sixties," he says now. "I have to admit, at one time I was a *Star Trek* fan — I still enjoy it. I'd been asked to do some of the exhibit rooms, and I installed the *Dark Star* model in one of them, just for the heck of it."

Douglas Trumbull, fresh from his directing debut on *Silent Running* and then engaged in preproduction on *Pyramid*, was one of the guest speakers. "He came into the exhibit room and

article by
Brad Munson

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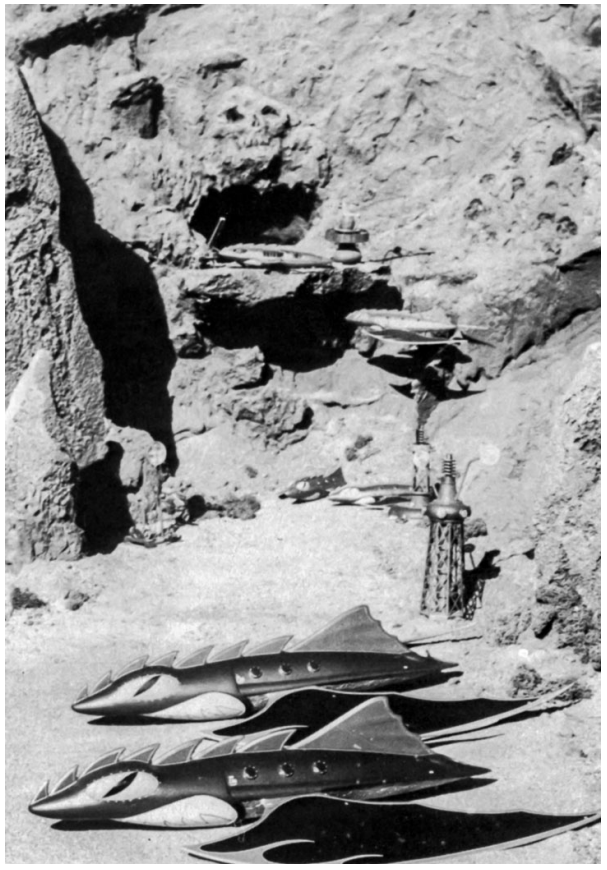
asked who had made some of the models — including the *Dark Star*. I raised my hand, and he said: 'Give me your number. Maybe I'll give you some work someday.' " Trumbull's *Pyramid* would soon collapse, but a short while later he called Jein in to work on a demo reel for an Arthur P. Jacobs project called *Journey of the Oceanauts*. Actors Eric Braeden and Bruce Davison were suspended on wires for the ten-minute test and a special matting technique was used to simulate their being underwater. Greg Jein and Tom Scherman made the fanciful miniature submarines. The project looked good, but Jacobs' untimely death brought it to a screeching halt.

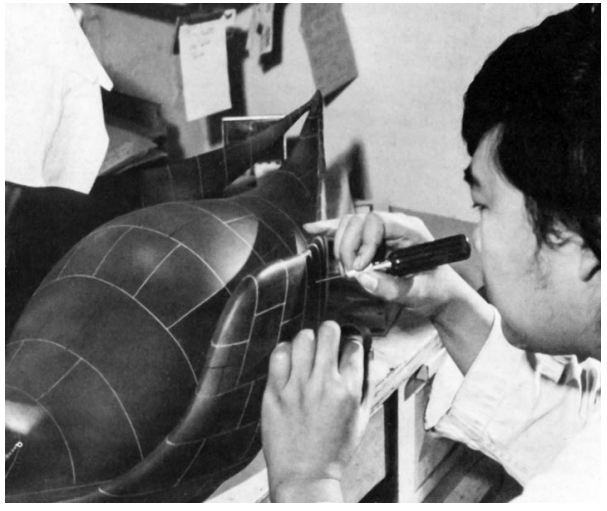
As a result of Trumbull's involvement in the Magicam video compositing system, Jein next went to work for the newly-formed Magicam organization. One of their first projects was *War of the Worlds*. "It was a TV pilot that had nothing to do with H.G. Wells' *War of the Worlds*, other than it was a Paramount property and Paramount owned the title. It was kind of a *Mission: Impossible* in outer space. A very mediocre thing that never got on the air." Later, Magicam was established as a subsidiary of Paramount, and Jein worked on a variety of other quickie projects. "We got this one thing called *The Space Watch Murders*, which later became *Murder on the Mind*. It was one of those really bad videotape ABC Late Night Mysteries. Abominable, but it gave Magicam a chance to use some of its equipment." Jim Dow and Jein were in charge of building the models for *The Space Watch Murders* — some of which, including a great globular spaceship, were cannibalized from the defunct *War of the Worlds* pilot.

Next came the *Wonder Woman* television pilot set in World War II. "I had to build the glass robot plane that lands on top of a German bomber at the end of the film. The bomber had to match stock footage from *The Battle of Britain*, but the Heinkel 111s in that film were not like the Heinkel 111s in the kits because they'd been modified for current aviation use. So I had to modify the kit. Then, since the kit only came in one size, I had to scale Wonder Woman's plane to that size as well — I think it was about six inches long." There was also work on a dogfight sequence between Lyle Waggoner and enemy ace Eric Braeden, none of which appeared in the final version. The producers replaced the scene with stock footage from a film called *Thunderbolt*.

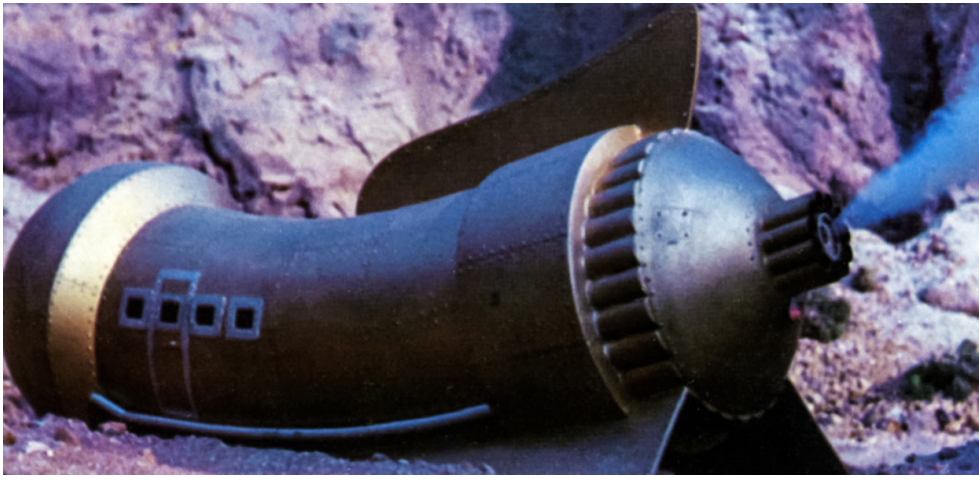
(Doesn't it bother Jein — to work long and hard on models, effects, and explosions, only to have them left on the cutting room floor? "There was some of that in *Flesh Gordon*," he confessed. "A lot of people were saying, 'What a gyp!' But I'm more realistic now. I think my satisfaction comes — legally — when I'm happy with what I've done and I can go up to the director of photography and say, 'Is that good enough for you?' and he says, 'Yeah.' ")

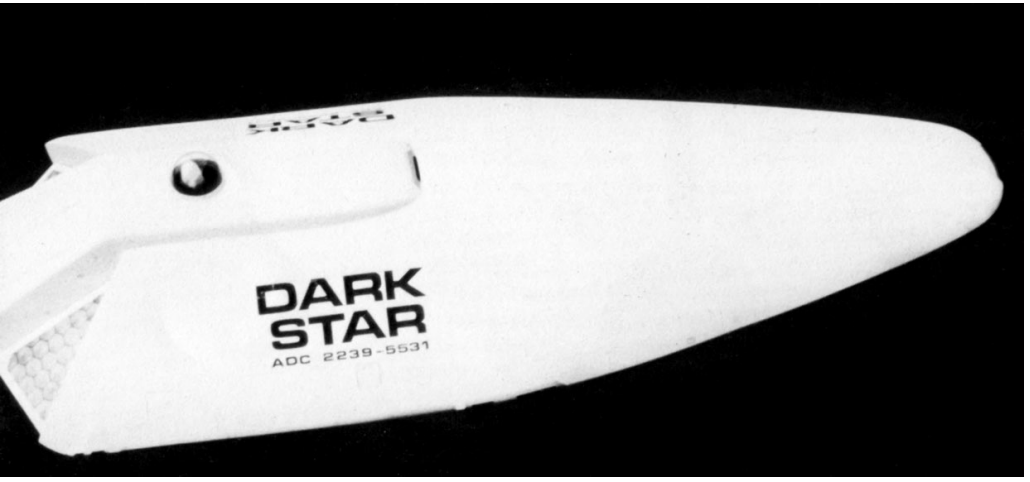
After *Wonder Woman*, there was work on *The UFO Incident*, a superior made-for-television movie starring Estelle Parsons and James Earl Jones as Betty and Barney Hill. There again, most of Jein's work — "I built the ship and Jim Dow built the forest" — never appeared in the film. "I think there's one scene in it, about six frames long — where they flash the ship."





Greg Jein's first motion picture work involved constructing a bizarre assortment of miniature spacecraft for the low-budget porno parody, Flesh Gordon. *Among them were a number of dragon ships, built in eighteen-inch and eight-inch sizes for use in Emperor Wang's forced-perspective airdrome set. / Jein adds finishing touches to Prince Precious' swan ship. All the* Flesh Gordon *ships were carved from urethane foam and coated with resin. / Jein sculpted a tiny Dale Ardor to be menaced by a stop-motion creature dubbed the Nesuahyrrah by the effects crew in amagramatic homage to Ray Harryhausen. / Jein also provided detailing for Tom Scherman's miniature representation of Emperor Wang's castle, conveniently constucted from pots and pans and other household utensils. / Dr. Jerkoff's* Flying Phallus *was designed to be flown on wires, with a hollow compartment built into the tail for fireworks.*

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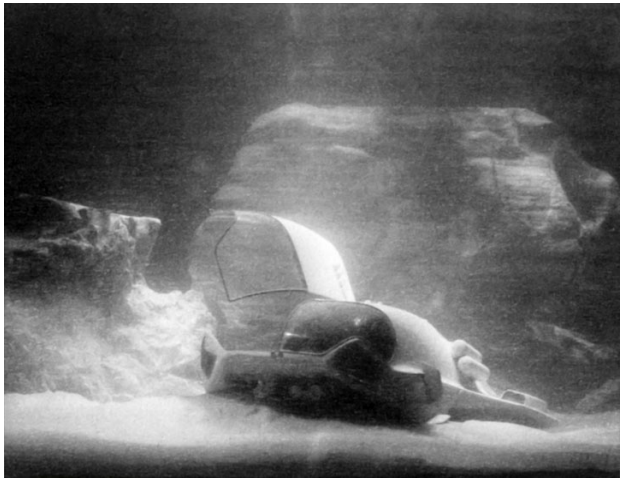

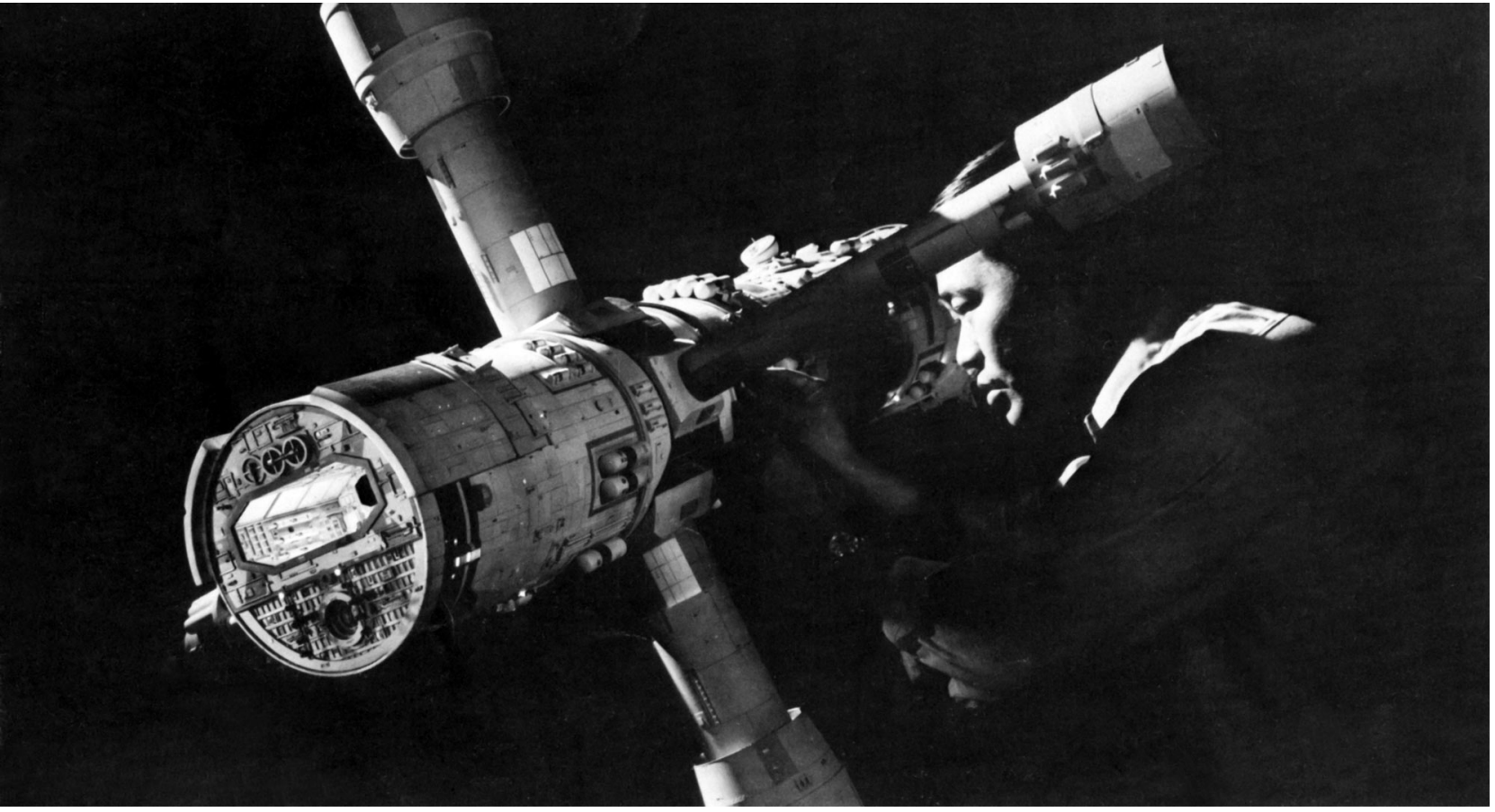

The rest of Jein's time in the mid-Seventies — until 1975 — was taken up doing commercials. Then one day he got a call from Douglas Trumbull's project manager on the new Steven Spielberg production, *Close Encounters of the Third Kind*. "They needed someone for about three months to 'build a few things,' was I think the way they put it." Jein finished the Hunt's Tomato Catsup commercial he was working on for Cascade, and joined Trumbull's super-secret effects unit. The three-month temporary position was to become an eighteen-month hitch.

His first assignment was to produce a tabletop landscape representing the view from Crescendo Summit, a curved stretch of Indiana highway where a flight of UFOs perform dazzling low-level aerobatics. When completed, the miniature was to be photographed and used as a front projection plate during location shooting in Mobile, Alabama. "It was a forced perspective miniature," Jein recalls, "about twelve feet by five feet. Originally, we went by drawings made by Dan Goozeé, one of the production illustrators. He'd made a black-and-white drawing of what the scene would look like. Then we made a slide of it, put it into a projector, and projected it onto our table from the same angle the camera would be shooting it. After we painted the terrain white, the black lines from the drawing would show up like roads on the table and we'd just chart them off and go from there. That first miniature took us about six weeks, because it was the first time we'd done anything like that. We put in every bloody little furrow. After that, we kind of abbreviated the process. Doug would give us a quick sketch, and I'd just work from that, sort of like a surveyor. Usually we'd just put the sketch on an acetate cel, put the cel on a stand back where the camera would probably be, and then just sort of eyeball it from there. We had pretty good success, I thought — but in all honesty, when you shoot everything at night, it helps a whole lot."

Normally, a forced-perspective miniature can only be photographed from a single angle — give or take a slight variance — but for the Crescendo Summit setting, Jein and his crew actually built in two vanishing points. "You could shoot from the right end of the table looking left or shift around to the left end and shoot right, and it still felt like it was working. I don't remember how we did it — I think it was an accident. Somebody said, 'Hey, let's make these lines go *this* way,' and the rest of us said 'Okay.' "

Another of Jein's meticulous miniatures was used in what became known by the crew as the "Quarter-Pounder" shot — a sequence in which three saucers cruising down a deserted highway pause momentarily to puzzle over a McDonald's billboard. "That was a small miniature — like about five by five — and the horizon and the terrain in the background we got basically by taking the first miniature and wheeling it behind there with a different vanishing point." Other landscape work included the miniature crossroads where Neary sees his first saucer, and the Devil's Tower model that provided the setting for the mothership's climactic appearance. "We built quite a few little insert miniatures, too — a lot of the shots where the saucers were seen over the ground used miniature terrains so the lights could reflect off them."

One major miniature never appeared in the movie — a ten-by-six representation of the backside of Devil's Tower into which the live-action footage of the secret base of operations would be matted. It was decided, however — after the fact — to use a matte painting instead. "It was very detailed, with lots of trees and rocks and things. We used various scales of granite rock, and by the time we got around to breaking it up, it weighed something like eight hundred pounds."

One day Richard Yuricich, director of photography for photographic effects, came to Jein with a unique problem. A scene in the film called for three UFOs to whiz through toll gates at the end of a bridge, throwing light in every direction and startling the guard. Since the live-action photography had already been completed in San Pedro, Yuricich asked Jein if he could build an exact duplicate of the tollbooths in forced perspective, so that proper interactive lighting effects could be added. "That one miniature gave us the worst headache — I mean, literally, a headache. It was only about four feet by four feet, but it had a weird, rapidly diminished perspective. The model was mainly nondetailed, just to superimpose highlights over the real tollbooth, but it had to line up *perfectly* with the live-action plate. So we had to keep sighting through a film clip in the camera viewfinder, and then run out to the miniature with a white stick and try to figure out where the line was. It drove us crazy. I also built the saucers for that shot. They were forced-perspective half-saucers, rather than whole saucers. The largest was about twelve inches in diameter and they were built to match the standard saucers that were being shot in motion control. With the exception of one detailed saucer that was made, those were the only UFOs I actually worked on."

The miniature tollbooth was painted a flat gray, and the lighted half-saucers were mounted on a small I-beam track Don Trumbull and Bob Shepherd rigged. Then they were run through the miniature set to create the various lighting effects that would have been natural to the real tollbooth, right down to shifting shadows and reflections in the window. Once completed, the footage was simply double-exposed onto the original live-action tollbooth footage. The eyestrain paid off with a final effect that is one of the most convincing in the film — virtually undetectable as miniature work.

Finally, there was the awesome task of building the mothership. "The ship had originally been conceived as a big black shape that would come over and just block out the sky and clouds and everything." A four-foot prototype had even been constructed. "It looked like what you'd get if you took a snowcone holder and cut it right down the center — like half a teepee — and then put a hemisphere on the bottom of it." Spielberg later decided, however, that he wanted a more flamboyant design — something along the lines of a huge oil refinery at night. Trumbull amplified the concept by suggesting sort of an airborne Manhattan skyline with tiny lights and windows to

The Dark Star *spacecraft was built by Jein from a Ron Cobb design and later detailed and photographed by Dan O'Bannon. / Jein constructed a minisub used in a Douglas Trumbull demo reel for the unrealized* Journey of the Oceanauts *project. For the actual test, a still photograph of the model was used so that footage of the actors could be rear-projected inside. A special matting process provided the underwater effect. / Trumbull later had Greg Jein cannibalize the dome release arms from the* Silent Running *spacecraft to make an orbiting platform for a prototype Showscan dark ride he was developing at Future General. The platform was subsequently used in the telefilm,* Murder on the Mind.

sell the idea that the ship was, indeed, a giant city of light floating through space.

The curved dish-shaped underbelly that was to be used on the black snowcone mothership would be incorporated into the new concept since it had been constructed and was already being photographed using moire light patterns. Given those parameters, production illustrator Ralph McQuarrie was brought in to do a series of concept drawings.

"There were no hard drawings on the ship," Jein says. "We worked primarily from a Ralph McQuarrie painting. The underbelly — which had already been built by Jim Dow and Ken Swenson — was made out of blown plexiglass and reinforced with wood and steel piping so it could be mounted on a gimbal rig. We used that as a starting point and proportioned the mothership up from there. The main platform on top of the ship I sculpted in quadrants out of clay and fiberglass. There were not very many symmetrical parts to the ship — there was no repeating pattern and every section was different from the other. In fact, it got so complicated that we began coding everything like the different boroughs in New York — this was the Manhattan area; this was Staten Island. It made life a lot easier. The large cylindrical structures were made out of aluminum tubes in various diameters with plastic caps on them. Lots of the arms were made out of commercially available telescoping brass rods with various shapes attached. There were thousands and thousands of wires and fiber optic bits and grain-of-wheat bulbs and grain-of-rice. It was a real plumber's nightmare. Larry Albright and Peter Anderson did a helluva job hooking it all up, and there were very few blow-outs throughout the whole shooting process."

Jein resisted the traditional method of using parts scavenged from commercially-available plastic model kits for detailing the ship. "There's an ever-increasing chance that people will recognize what those parts are, and it'll take away from the believability of it all. We did use a few, though. We bought six of the Cousteau *Calypso* kits and took parts off their diving bell as more or less antenna-like pieces to put on the surface of the ship structures, just to break up the cylindrical shapes. The only other things we bought were tons of model railroad track couplers, just to give some detail to the bottom of the dome. But most of the detailing was all hand-fabricated from sheet plastic and metal rods and things like that."

Jein and his crew were given five weeks to complete the mothership. Working six and seven days a week, twelve hours a day, they still went over it by three-and-a-half weeks. "To break up the routine we started putting on funny gags. Dave Jones, one of the model makers, made a little R2-D2 from *Star Wars* and stuck it in back of some tubes. When Doug saw it, he said, 'That's a good gag; let's put it up front.' So I made another one, with a little fiber optic in its head, and stuck it in front of a bank of lights. You can see it in the film. It's right when the mothership first appears in closeup behind the mountain. Melinda Dillon turns around and says 'Oh, my God!' and there're four lights in a row and R2's standing upside down in front of one of them with this little red light in his head. We had lots of other gags, but that's the only one that shows. We had a shark chasing a little frogman — two of them, actually. There's a Volkswagen bus stuck on it; some World War II fighter planes — and there's a TIE fighter built around a light on one of the arms. There's a miniature graveyard on one of the levels of the ship, with crosses and everything; and there's some people hanging off various rods. And in some of the windows in the round globes, we had Mickey Mouse and some other strange, recognizable silhouettes."

The most tedious part of the mothership construction was drilling the hundreds of thousands of tiny window holes in the neon-fitted aluminum tubes which covered the ship — not randomly, but in horizontal and vertical patterns so the tubes would look like giant architectural structures. The insides of the tubes would then be polished and fitted with different colored gels, and the outsides painted black. "We had an army of people — whoever wasn't busy — just drilling holes. *Everybody* was drilling — the model crew, the secretaries, even Steven was doing it."

Once all the detailing was finished, the mothership miniature — approximately four feet in diameter and two-and-a-half feet high, with spires adding another foot to its height and two feet to its diameter — was delivered to the camera crew. His *Close Encounters* taskings essentially completed, Greg Jein stayed on, working with mothership photographer Dennis Muren and the rest of the crew on last-minute repairs and alterations.

During this wind-down phase on *Close Encounters,* Jein was asked by stop-motion animator Dave Allen to produce an alien spacecraft for a low-budget Charles Band production, *Laserblast.* Of particular interest to Jein — who had always worked from designs provided by others — was the fact that he was being invited to design the ship as well. He prepared several concept sketches; one was selected, and he set about building it at home. Two weeks later, the eighteen-inch model was delivered. *Laserblast* notwithstanding, it seemed to Jein as though the months of ceaseless and frequently crazed work were at last coming to an end. Steven Spielberg, however, had other plans.

"One day, when we were finishing up on *Close Encounters,* Steven talked to me about this next picture he had. I don't remember exactly what it was called at the time — I think it was something like *The Night the Japs Attacked.* I remember telling him I didn't think the title would go over too well." Nevertheless, the idea of working on an epic comedy of Pearl Harbor paranoia intrigued Jein, so he procured a number of World War II-vintage models and put them together as visual aids for Spielberg. Some weeks later, he was recruited in earnest to supervise the extensive miniature work that would be required for the film — now retitled *1941.* Two major miniature settings — period recreations of Pacific Ocean Park and Hollywood Boulevard — demanded an expansive workshop area, so the preproduction unit ultimately set up operations in a vacant hangar at the Burbank Airport.

But the *Close Encounters* project was not quite finished for Jein — not yet. "I was three weeks into preproduction on *1941*

A series of forced-perspective miniature landscapes were built under Greg Jein's supervision for Close Encounters of the Third Kind. *Included was a detailed representation of the Crescendo Summit area where a flight of UFOs put on a dazzling high-speed lightshow. Working from concept sketches, Jein and his crew fabricated acres and acres of Indiana farmland. / A miniature crossroad setting was built for the sequence in which Roy Neary's truck is overtaken by a hovering saucer. / The Crescendo Summit set was photographed as an 8x10 transparency, enhanced with airbrushed horizon haze and pinpoint light sources, and used as a front projection plate during principal photography. Since the sequence took place at night, however, most of the intricate detail was ultimately lost.*

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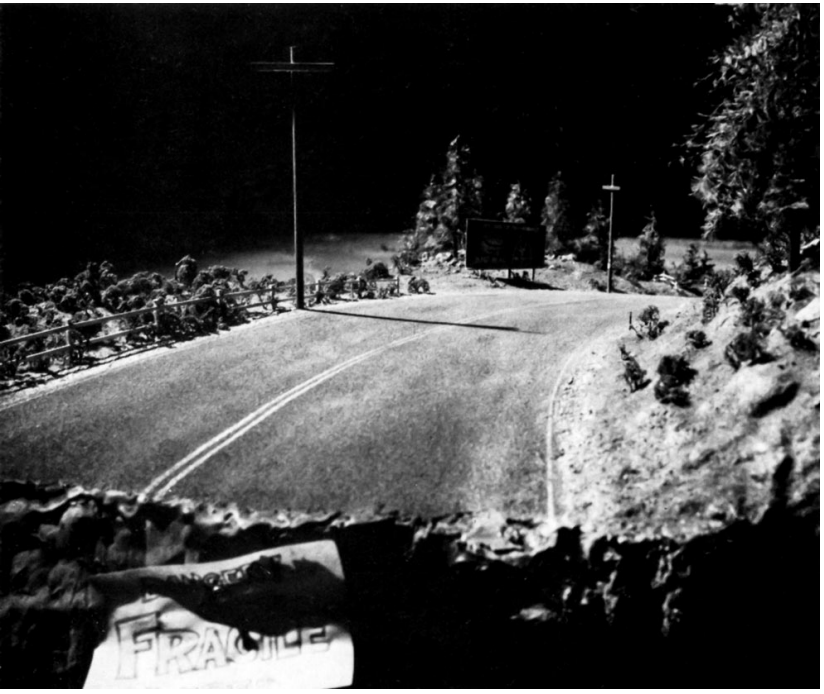


when Steven came back and said he needed some additional footage with the 'stick-man,' as we called him — the big marionette alien Bob Baker built for the end. Just because there was no one else around and I was available, he said, 'Could you provide a miniature backdrop he could walk down?' And I said okay — naturally. But the stick-man was over six feet tall, and when I proportioned that out, I figured the portal alone would have to be something like fifteen or twenty feet tall. So I more or less turned that project over to the staff construction shop. It was really more of a full-size prop anyway." Jein did, however, remain on hand to be certain the oversize miniature was compatible with the work he and his crew had already completed on a much smaller scale.

Back on *1941*, the Ocean Park setting was given first priority since Spielberg desired to film its destruction, by a misguided Japanese submarine, before the start of principal photography. Construction began at the hangar in October 1977, and from that point forward, the dates all run together for Greg Jein. "We worked a *long* time on the miniature buildings for the amusement park set. We spent five or six months doing research, building structures, aging them, and then getting them all approved. We just sort of built and built and built." It was a good example of the sort of model-making overkill that is typical of the miniatures business. With directors and camera-people changing camera angles and concepts on an irregular but frequent basis, miniature builders like Jein often make more of the model, and in greater detail, than is really required. "All the arcades, all the food stores, all the little buildings — there's not an empty room in any one of them. We put something behind every window. The deli had ham, sausages, turkeys, jello, candy bars, popcorn. The game racks were full of prizes. The hotels had little venetian blinds. There were even pool tables, coats on the wall — weird stuff like that. You actually saw only about ten percent of what we had, but when we got into the shooting, we were glad we'd gone to all that trouble because it showed up in some of the closer angles."

But shooting had its own set of problems. It took a week's worth of twenty-four hour days to move the completed miniatures from the Burbank Airport and install them on Metro-Goldwyn-Mayer's massive Stage 30 where the shooting was to take place. The set itself was built on a large platform so that all the electrical wiring could be run underneath for ready access.

Once everything was in position, William Fraker, director of photography for the film, decided that the scale and atmosphere could be enhanced by using smoke as a diffusing medium and by covering the set with a layer of moisture. "That meant hosing down the buildings and the concrete areas — and all the electrical wiring was right underneath. At first I went: 'Oh, my God. If water gets into it, were going to start a fire.' We did have a few problems — transformers blowing up under the stage and such — but we struggled valiantly underneath the pilings to wire things up. It was like working in a moat."

To make matters worse, the artificial ground had been sloped up to meet the miniature structures in order to avoid the impression that they had been simply laid out on top. As a result, access to the buildings had to be from underneath only. Holes were cut from below, and a complex of ladders was constructed so the miniatures crew could install electrical wiring and detail the interiors. "We spent many, *many* hours crawling up these things and trying to fit into these little houses. It was like working in reverse. Cuts, bruises, scrapes. It was terrible."

The most elaborate single effect in the sequence involved a twelve-foot ferris wheel that had to be blown off its moorings, roll down the park's pier like a huge wagon wheel, and then fall into the ocean. The original rig that Jein and his crew worked with for many months failed to function when it was finally hooked up on the stage, so they had to come up with a second idea — fast. Ultimately, they installed an overhead track that would guide the wheel down the pier by means of support cables tied to the axle. The ferris wheel was suspended about an inch off the pier because the effects crew feared that actual contact would throw its rotation off and make it bounce unrealistically. But Spielberg wanted a plume of dust and debris to spout up behind the ferris wheel as it careened down the pier. The answer to the problem involved a specially designed shiv and pulley system — a small independently-operated sled with a nail in it that would trail just behind the rolling wheel, pulling up miniature balsa wood planks and throwing out fuller's earth to make a fountain of flying debris.

Finally, Spielberg had decided that he wanted the ferris wheel lights to remain on as it went down the pier. That meant wrapping a power cord on the camera-away side of the hub, and keeping it loose enough so it would not disturb the wheel's rotation, but secure enough so it would not detach.

It was a one-take set-up.

On the day of the actual filming, the special effects and miniatures crew arrived at 5 a.m. Last-minute preparations were made — illuminative circuit boards hooked up and tested; debris piled in prearranged ruts; the overhead rack tested one last time. Finally, two men took position next to the wheel and used a belt crank to start the ferris wheel spinning. "Two guys just spinning the heck out of the thing," Jein recalls. "Then Steven yelled 'Action!' and these guys would have to pull out the crank and get out of camera range real fast, ducking behind buildings."

The moment came. A little drive motor took the ferris wheel off its mooring and pulled it along the overhead track by cables attached to small metal collars at the wheel's hub. It rolled steadily down the pier, lights twinkling. A man with the pulley system ran along an off-camera runway, perfectly timing the flying debris. When the wheel reached the end of the pier, explosive caps — bolt-cutters on the support wires — exploded, and the ferris wheel's own weight carried it over the edge. As an added embellishment, the effects crew had laid primer cord just below the waterline to detonate on cue and create a huge splash. The scene was completed.

There was silence from the far end of the pier where the

Another miniature setting was constructed for the "Quarter-Pounder" shot — a shot fabricated entirely in the effects facility. / The forced-perspective nature of the set is readily apparent in this side view. Effects supervisor Douglas Trumbull directs Greg Jein and Michael McMillen in the last-minute placement of miniature trees. / In the final composite, the barnstorming UFOs — shot as separate elements in a smoke environment — barrel down the deserted highway, flash momentarily on the McDonald's billboard, and disappear around the corner. Stars were added later on the animation stand.

cameraman — and the director — were stationed. Greg Jein went "Uh-oh."

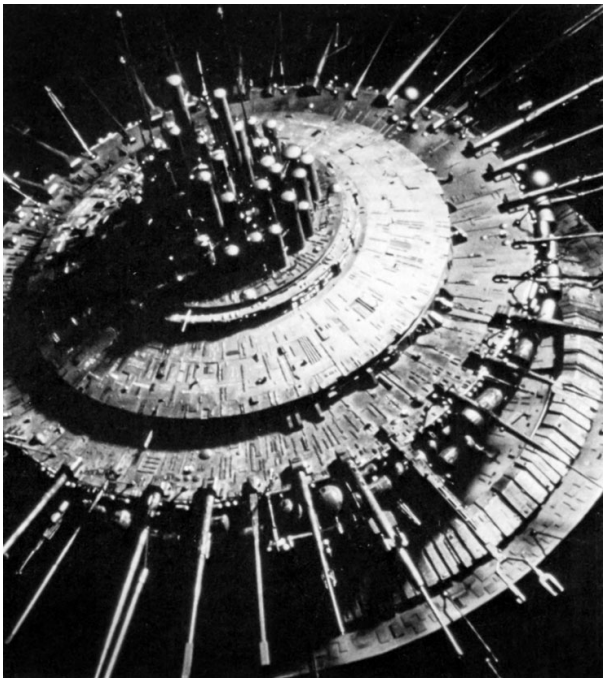
"Whenever there's silence, everyone starts mulling around Steven. He was looking at the ground, looking at the pier — thinking. Finally he came down and said, 'Can you guys get it ready to shoot again? And this time, let's make the lights stay on as they go underwater.' "

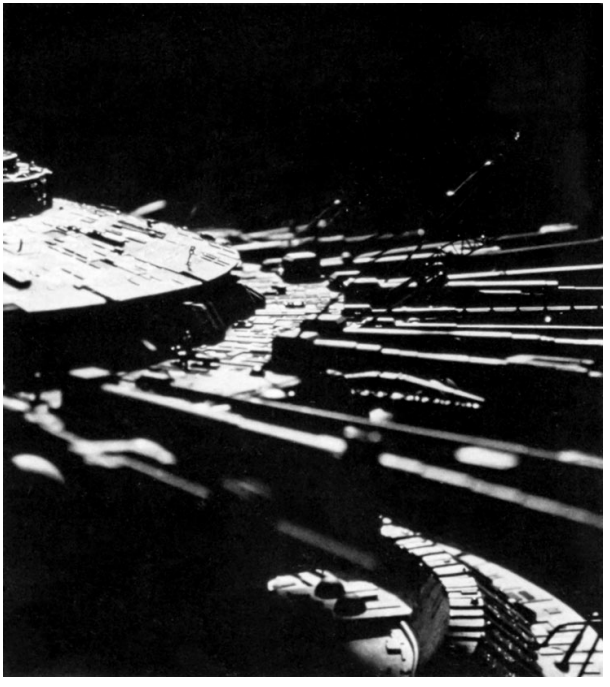
Studio frogmen dredged the ferris wheel out of the water. The primer cord had damaged the superstructure, and most of the lights had blown out. No one had given any thought to keeping them on underwater. With a full production crew standing around on company time watching, Greg Jein and his crew made a careful estimation of the time required for necessary repairs and modifications. Finally, he indicated they might be able to have it ready for a second shot — *late* in the afternoon. The damaged wheel was straightened and reinforced, circuit boards were repaired or replaced, and explosive charges and cables were reset. Someone located a resin paint in the staff shop and slopped it on as a sealant. "We went crazy that day, trying to get it done. But the second take worked out fine. Better than the first one, actually." There was no need for a third.

Originally, there was to be another, even more complex, explosion-and-destruction effect — a carousel in the middle of the park was set to blow off its hub, skip back into another building, and destroy that as well. But something unexpected changed that. "We had effects rigged to blow it up — and it would have been a real difficult thing to do; even more difficult than the ferris wheel, because it would have involved a lot of miniature area around the carousel being damaged as well. Then Steven came in one Saturday — there were no weekends — and we lit it up for him. The little horses went up and down, and the little lights twinkled on and off, and he said, 'Hey, that's pretty nice!' He decided not to blow it up — eventually he took it home."

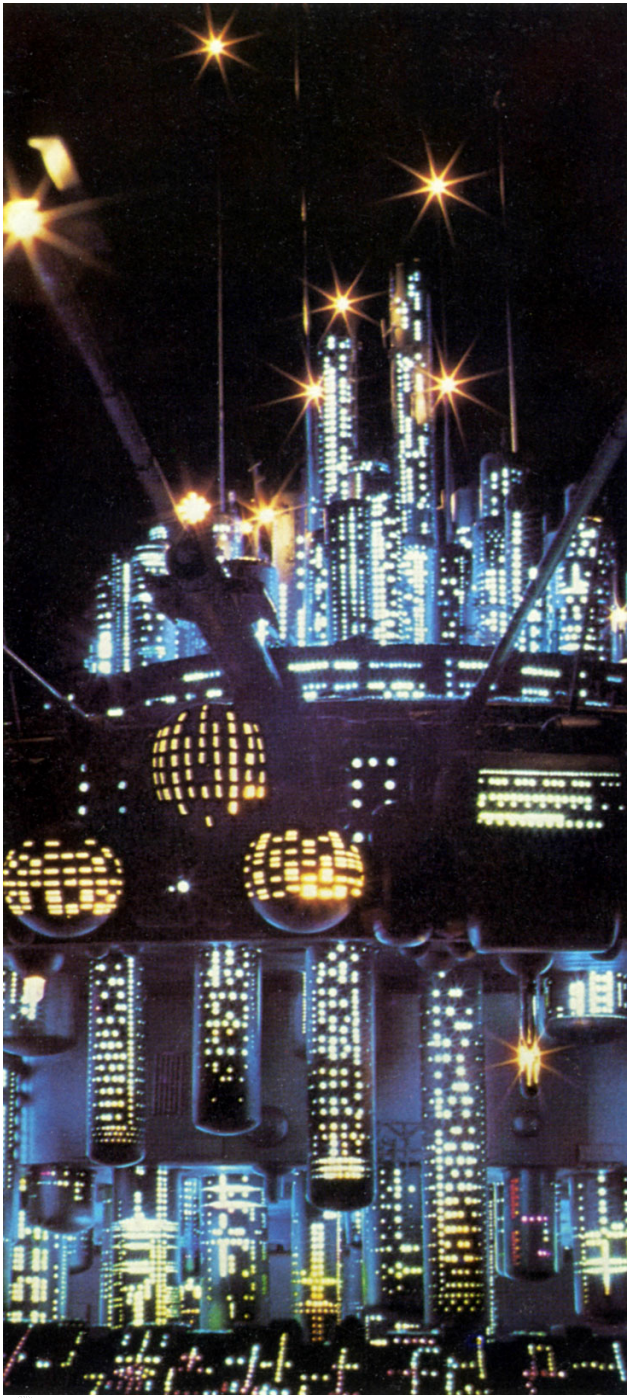
The carousel destruction was far from being the only effect that never appeared in the final film. "Originally, the submarine fired eight shells before it actually found the ferris wheel. There were two tall structures in the back that were supposed to go. The tallest one, the slide, takes a hit and part of it falls down. Another building that had sort of a church steeple blew up twice — that looked pretty good. And the Pacific Ballroom, which you can see prominently in the film — that whole building blew up. Probably twice as many things were blown up as were used in the film."

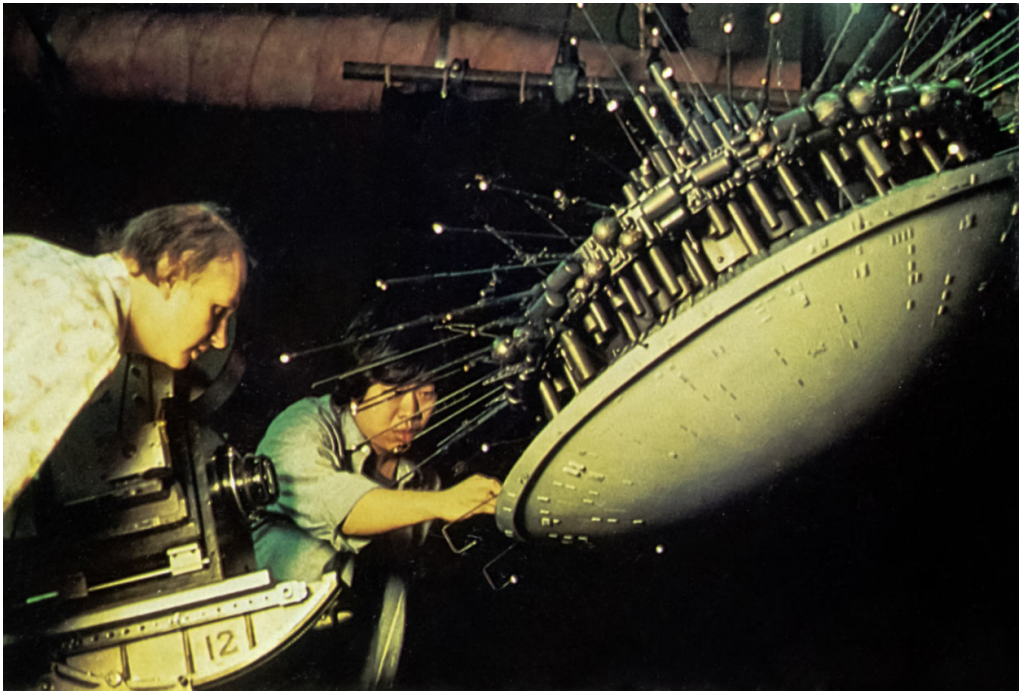
A great many of the blasts, both used and unused, did not rely on miniature explosive charges at all. "Flames and water are probably the two hardest things to scale," Jein says, "so instead of actual charges, effects experts will frequently use simple flashbulbs dyed red to give the light and color but not the flame. Another thing they use is something called an air mortar — which is just a large air tank with a funnel on the end of it. When it's triggered, it releases all the air at once. You can rig it with all kinds of debris, but just the force of the air alone is enough to

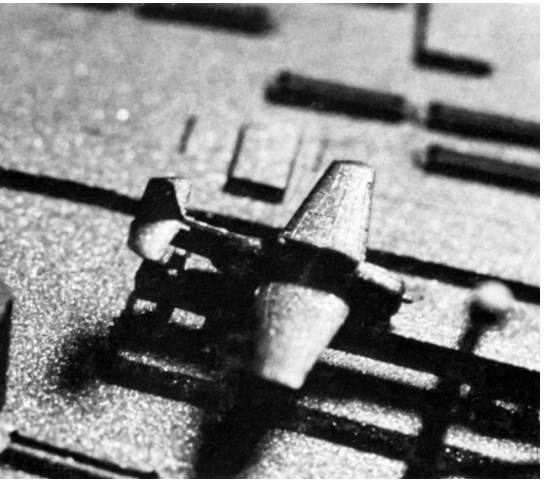


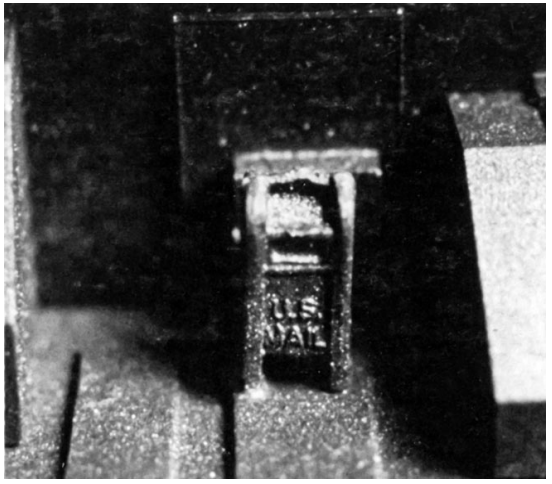


Greg Jein won an Academy Award nomination for his work on Close Encounters. *His most demanding assignment on the picture was the construction of the alien mothership, a massive miniature made from fiberglass, plastic, and aluminum tubing, and crammed with neon, incandescent, and fiber optic light sources. Unlit, and without the smoke environment in which it was filmed, the painstaking detail incorporated into the ship is plainly evident. / Arms and spires were made from brass rods, and plastic pieces were hand-fabricated. Very little of the detailing was taken from commercially-available plastic model kits. / Thousands of minute holes were drilled into neon-cored aluminum tubes to enhance the illusion that the ship was a vast intergalactic city of light. / Greg Jein adds detailing to the ship's spindly surface. / As effects cameraman Dennis Muren prepares for a closeup, Jein makes final adjustments on the mothership miniature.*





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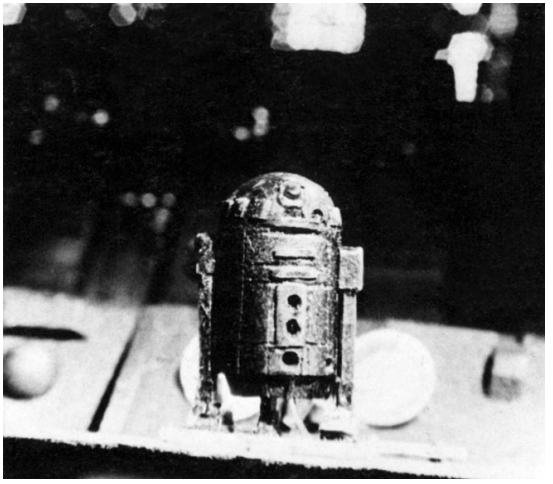
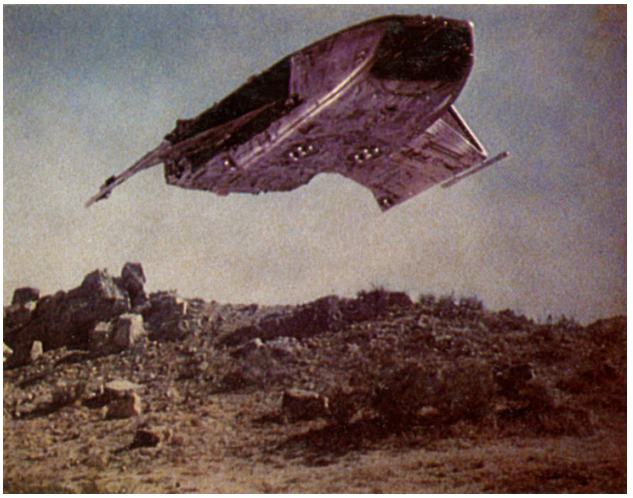




blow a breakaway building apart.''

A whole variety of vehicles were built at the same time the Ocean Park set was under construction, including tanks, cars, planes — even a twenty-six foot submarine. ''Originally, we made a submarine that was smaller, to use in underwater shots, but they decided to use stock footage instead.''

Finally, Jein and his crew built the vehicles in one-and-a-half inch to a foot scale; and once the scale was determined, everything had to be the same. ''Planes were flying over the park and submarines were appearing with the planes, so it all had to work together.''

The submarine was made much like a wooden airplane model. A bulkhead and a ribbing system were constructed and then covered with sheet urethane foam that was heated, tacked on, and resined over. Details were made in the staff machine shop and glued on. A large keel was fabricated in steel to give it negative buoyancy. ''Also we had to have it moving through the water, and we wanted to give the effect of it clipping along at a better speed than it was. So we rigged little jets of water to hit the side of the ship, giving it a false spray. Even if it was standing still, the water jets would make it look like it was moving right along.''

Jein and his crew got a lucky break on the P-40 plane models used throughout — they located a commercially available P-40 kit in just the right scale. ''The only problem with the kits was that there was only one model in the right scale, and the company had just gone out of business. So we ended up calling all over the country to get four of them.'' The hulls were fiberglass, the wings were styrofoam, and the rest was wood and plastic, except for the vacuformed clear plastic canopies. The canopies were produced in quantity by Brick Price since they were constantly burning up or melting during production. Despite the havoc, however, all four P-40s weathered the explosions, crashes, and dogfights relatively well — though one was nearly totaled in a close encounter with the ferris wheel. ''Steven wanted the P-40 to get closer and closer to the ferris wheel. And the next thing — whack! In the dailies you could see the wings falling off, but the fuselage was still on its guide wire so it kept on streaking.''

Finally, after six weeks of systematic demolition, what little remained of the once-magnificent Pacific Ocean Park set was taken down. Greg Jein's crew was far from finished, however. Instead, they returned to their Burbank hangar to begin work on the second major phase of the miniature operation — the Hollywood Boulevard set. Even though vast amounts of period research materials were accumulated to aid in building an exact replica of the landmark thoroughfare, a fair amount of artistic license was taken in the arrangement of the buildings. The Broadway department store, for instance, was moved from one side of the street to the other, and key buildings spread out over several blocks were telescoped into one. It was primarily a function of space. ''For the Ocean Park sequence, we used the biggest stage at M-G-M. Now, for the Hollywood Boulevard set, we had the

As a break in routine during the laborious two-month building period, Jein's crew began incorporating dozens of minute gag elements onto the mothership's textured surface. Only the diminutive R2-D2 is discernible in the finished film. / Greg Jein considers the mothership's ascent over Devil's Tower to be his most satisfying film contribution since he was personally responsible for nearly all the physical elements of it, including the sculpted stone monolith and the surrounding terrain. / In the closing days of Close Encounters, *Jein was invited to design and construct an eighteen-inch alien spacecraft for* Laserblast, *a job he completed in only two weeks. / The alien vessel hovers in the background while one of its occupants — animated by Dave Allen — neutralizes an alienized earthling.*

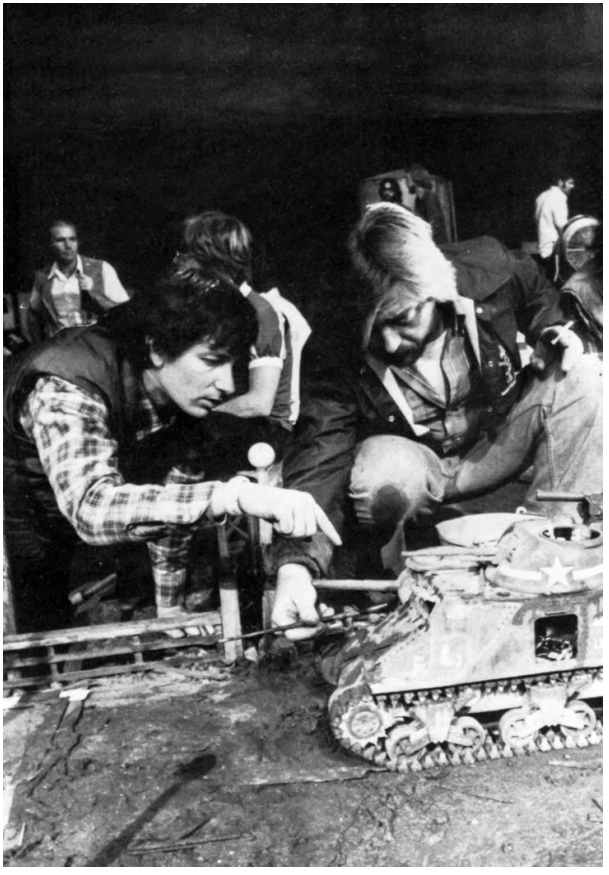
biggest stage at Warner Brothers — Stage 16 — and we had to fit everything into that particular area." There were art direction problems as well — photographic and architectural angles that benefited by a slight rearrangement.

The largest structures were framed-in two-by-fours skinned with masonite. One — the Equitable Building — stood twenty feet tall. Access was much easier on this set, since the crew could leave off the rear of the building and install lights and detailing from behind. "Some of these rooms had real sets in them, right down to wallpaper and bear heads on the walls. Some of the windows were just painted on. Others were cut open and canvas was put behind them; then a painter came in and airbrushed drapefolds onto the canvas."

Originally, the Hollywood Boulevard set was keyed to be shot from a single angle — straight down, from above. For weeks, the miniature crew concentrated on detailing only the rooftops and upper stories. "We were never going down to the street," Jein says. "Then, halfway through, Steven changed his mind. For some of the new angles, we had to come up with a couple of hundred houses real fast and cheap, so we ordered a bunch of cardboard boxes from a box manufacturing company, cut windows in them and painted them black. Those are all the background forced-perspective buildings."

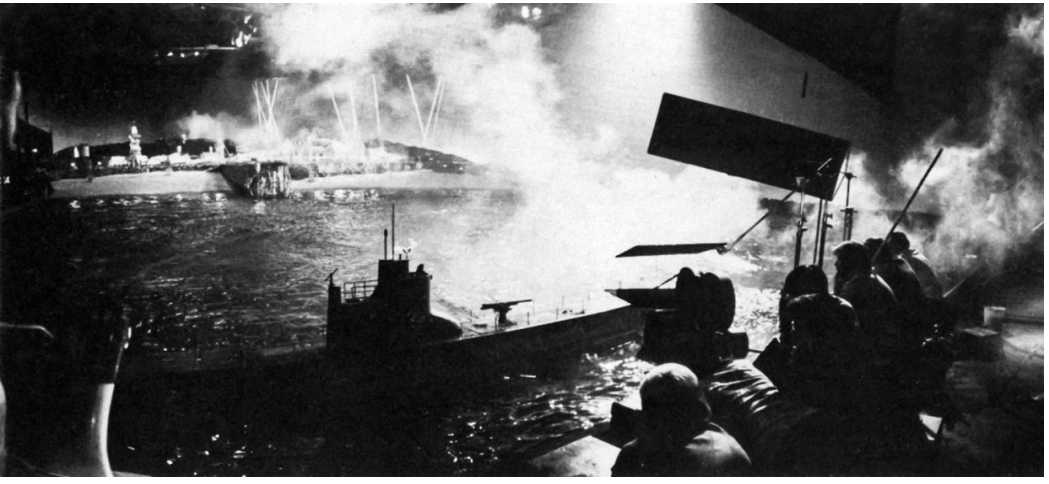
And though it was not in the original plan, the detailing did continue to street level. Detail, in fact, has always been of major importance to Jein. It is one of the elements that distinguishes the best, most realistic miniatures. "My primary concern is fooling the public long enough that they'll say: 'That's not a miniature. There's a Coke can there, and nobody would bother to put a Coke can in a miniature set.' I try to put a lot of detail in so the viewer will take it for granted that it's the real thing, not just a cheap painted flat or something like that. It's like surrealistic painting. Your image is enhanced by a lot of little things all over the place. It's as though you took a photograph from a magazine, or a picture on a TV screen, and looked at it under a microscope. It's made up of little dots. A lot of people will take something — let's say a model of a house — and paint it one color so it's got a uniform sheen across it. Very few buildings — even after one day — have that sort of sheen. You have to think in terms of a miniature plasterer or painter, and keep the brush strokes small and not really that uniform."

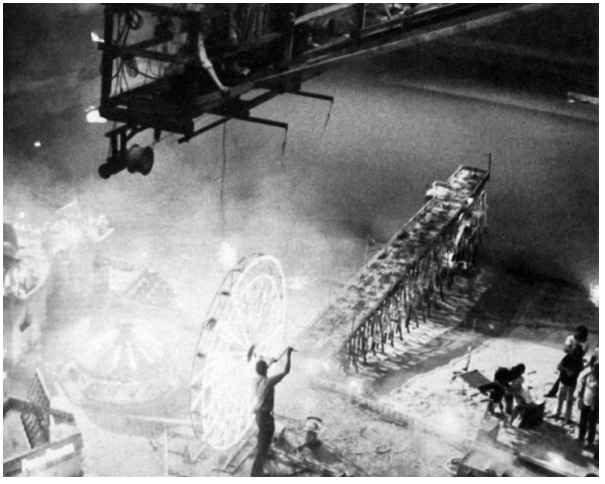
In both of the major sets for *1941*, Jein and his crew went all-out on detail. "It probably didn't show up that well, but in the amusement park we had little newspapers printed that said 'PEARL HARBOR BOMBED BY JAPANESE' — last week's news. There were thousands of them. And we just crumpled them up — they had text on both sides — littered them all over the ground, watered them down, and stepped on them. That's why I think the ground in the amusement park doesn't look like a miniature — it has too much junk all over it. We also printed up appropriate issues of *Life* magazine for those two weeks — one was an American flag and the other was MacArthur — and had them on the newsstands along with *Shadow* pulps and things like that."

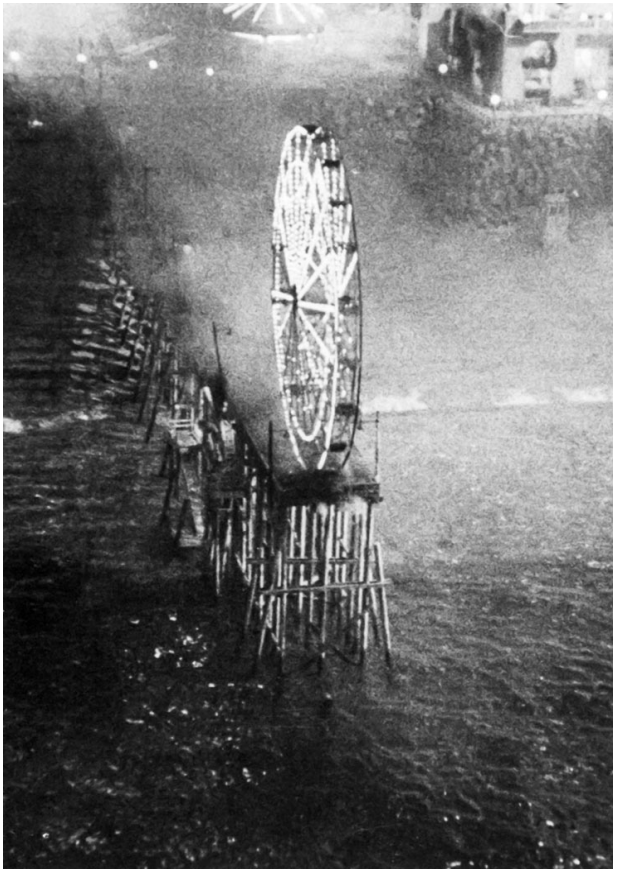


Greg Jein was presented with two major assignments on 1941. The first was a detailed reproduction of Pacific Ocean Park, which consumed most of one of the largest soundstages at M-G-M. Assisted by Ken Ebert and Sharon Lee, Jein positions one of the large-scale buildings produced by his miniatures unit. / Director Steven Spielberg examines a miniature mechanical tank featured in the sequence. / Jein and Spielberg on the amusement park set. / Nearly half the total construction time was devoted to detailing. Tiny newspapers, barrels, posters — even graffiti — created an air of verisimilitude which is characteristic of a Greg Jein miniature. / Director of photography William Fraker discusses lighting with his assistants. At Fraker's suggestion, the set was sprayed with water and engulfed in a smoky mist to enhance the scale.

HIGH BOY
SHOOTING







The Hollywood Boulevard set was decorated with equal care. "We had guys running all over the Valley, getting parts from dollhouse stores for fake facades and awnings. And we used a lot of stuff from the Ocean Park set, of course, like the telephone booths, newspaper racks, newspaper vending machines, gumball machines, et cetera. One of the biggest problems we had was when we went down to street level, and all of a sudden there were these Christmas ornaments and Santa Clauses and garlands and stuff all over the place. We added that at the last minute, and unfortunately, it looks like it. What we ended up using was not the same as what they had on the live set, but we just had to go with what we could get together on short notice."

The cars at street level were also a problem. Because of the relatively large scale, it was difficult to find commercially available car kits that were big enough. "We just had one basic model — a Monogram Model-T Ford, which is the convertible you see on the Boulevard. The others were vacuform ones we had from the Ocean Park set, with toy truck wheels. One of my guys had to go to every Sav-On in the Valley and buy these cheap little trucks to pull the wheels off them for our cars." Less prominently placed were a vintage Batmobile parked at the curb of a side street, and the Green Hornet's Black Beauty half-hidden in the shadows. Greg Jein particularly prized two red streetcars with radio-operated conductors that moved, though they never appeared in the final film. "Instead of street names on the front, we put in 'Spielberg and Fraker,' and we filled one of them with all these toy dolls. We had 'Charlie's Angels' and 'Happy Days' dolls doing weird things; the creature from *Alien* was the conductor." The laboriously-created streetcars, however, obstructed some of the low-angle camera shots, and were thus removed from view.

Problems with the moving automobiles were less-easily solved. The radio control systems had a habit of malfunctioning at just the wrong time. "We had some radio-controlled cars that cost us about eighty bucks apiece — expensive little suckers. We stripped them down and put our chassis on them — they had to have quick-change chassis, because we didn't want the same red car always going through and we only had four radio-controlled cars. We had to put headlights in them, too, which meant they had to carry a battery. So it was a lot of weight. But on dry test, they worked just great. The problems came when they watered down the set. The cars kept going through puddles and shorting out and doing all sorts of strange things. I imagine they were getting a lot of interference from low-band trucks and from other stages, too. There's one shot in the movie where a car spins out. That was an accident, but it looks great." Happy accidents aside, the cars had a tendency to die in the middle of shots, change speeds at irregular and unpredictable intervals, and even mix up their control signals without warning, switching to some other signal and doing something entirely unexpected.

The final Hollywood Boulevard set was about one hundred feet long. William Fraker's use of smoke and moisture to enhance the atmosphere and increase the illusion of great scale made many of the miniature Boulevard shots virtually indistinguishable

Filming the destruction of the park by a twenty-six foot miniature Japanese submarine required six weeks of painstaking work. / Perched atop the miniature pier, Greg Jein rigs a breakaway section to collapse midway, stranding the tiny tank at the end. / In one of the more elaborate effects of the sequence, the twelve-foot ferris wheel is blown free of its mooring, and rolls down the pier and into the ocean. Suspended by wires from an overhead track rig, the wheel is manually cranked by a studio technician and then released. / Breaking free, the ferris wheel careens wildly and then proceeds to roll down the pier. In actuality, it was suspended about an inch above the pier structure while a separate rig kicked up dust and splintered balsa wood planks. When the wheel reached the end, explosive charges severed the cables and it dropped into the water.

from their full-size counterparts. As elaborate and convincing as it was, though, it was still just a setting. The main focus was on an outrageous aerial encounter between a P-40 pursuit plane and a twin-engine Beechcraft — also built to scale by the miniature crew. The flying mechanism, reminiscent of Howard Lydecker's pioneering work in the field, was devised by A.D. Flowers and Logan Frazee. Basically, it employed four wires — one to pull on the nose, one to maintain tension on the tail, and one through each wing for stability. Weights, counter-weights, motors and muscle-power were used to propel the aircraft up and down the street. Banking maneuvers and barrel rolls were produced manually by rotating a control disc attached to the wing wires.

The model planes themselves needed special modifications to survive the rigors of miniature aerobatics — and to satisfy Steven Spielberg's frequent inspirations. "Originally, Steven was going to use animation for the machine-gun tracers on the wings — the little flashes. Then one day he said, 'Tomorrow, I want to see those wings flash.' It was bite-your-tongue time. But Robin Leyden and Mike Myers stayed up all night and worked out a little printed circuit board that was activated by a battery servo; so a guy could sit at the far end, where the plane was going to end up, and push buttons in a certain way to get the lights to flash. That was a real lifesaver for us."

Beyond the two major miniature sets and their associated land, sea, and air conveyances, Greg Jein worked on a number of other projects for *1941*. "One scene that was supposed to be a throwaway was where the two planes get into Los Angeles and shoot down the L-A-N-D on the HOLLYWOODLAND sign. Everything went okay, except the last letter got hung up — that's why it comes down a little late. If you took the film about twelve frames further, you'd see Steven's coffee cup come flying into the scene. He was a little angry." Another quick miniature was used for the scene of the flaming Beechcraft crashing through a palm grove, losing its wings, and skidding in. For that set-up, plumbing pipe was screwed into a wooden platform so the plane's impact wouldn't knock the trees loose. Foam and peat moss were wrapped around the pipes, and sego palm fronds were added to the top.

Another, more time-consuming project, was building the San Fernando Valley for a relatively brief shot in which the two planes go zooming off towards Hollywood. "We made little 'Monopoly' houses for that set — thousands of them — with little rubber-stamped windows because we were told they were going in close enough to see the windows on these things. I don't know exactly how many we had, but it was enough to fill up five console television cartons. Then we took a city planning map for the period, and we did it — street for street and building for building. It dragged on a lot longer than it needed to."

Finally, however, after more than twenty-three months of nonstop work, *1941* began to wind down, and Greg Jein was once again called in on a last-minute job that was supposed to be easy and ended up a monster.

Once the amusement park filming was completed, Jein and his crew set to work on an equally detailed period replica of Hollywood Boulevard. Built in forced-perspective, the largest of the foreground buildings extended twenty feet into the air. Radio-controlled automobiles and streetcars traveled up and down the famous thoroughfare, painstakingly adorned with seasonal Christmas finery. The Hollywood Boulevard sequence was shot at the Burbank Studios with the same mist and moisture effects that characterized the Ocean Park filming.

"Ever since *Close Encounters* ended," he says now, "various companies had been asking if I'd be interested in working on *Star Trek*. Magicam was interested in having me do some work for them; so was Apogee. Doug Trumbull had asked a couple of times, too, after he got involved. But I'd always been busy with *1941*. About the time I was finishing up, however, Doug came to me again. He still needed help on some of the 'smaller things' in the last part of *Star Trek* — just a few weeks' work." Trumbull, then engaged in producing the imagery for the Spock spacewalk sequence, put Jein and his associates to work on a series of planets which varied in size from two feet to three feet and were later photographed using motion control. They also constructed a barren desert landscape using water-based clay on a five-by-ten-foot sheet of plexiglass. A heat-gun was used to dry the clay and give it the appearance of a cracked seabed. When spotlights were applied to the underside of the miniature, the moving camera registered flashes of illumination emitted from the craters. "We also built what we called the 'space lips.' That model was based on a Bob McCall drawing and was made out of fiberglass and foam and lit with fiber optics. It was supposed to be some sort of space vehicle that looked like a pair of giant lips — heavily armored with all kinds of little doodads. After about three weeks on *Star Trek*, V'ger reared its ugly head. Doug came over one day and said 'No one has started the interior of V'ger yet, and we've got to have it in about three weeks.'

"At the beginning, we were handed some small paintings by Syd Meade, but it was very difficult to visualize the thing by looking at them because they were just conceptuals. So we spent a good half-a-week working up some schematics and making a small twelve-inch mock-up so we could tell where all these lines would actually fall on the model. Then, based on our mock-up, we made a full-sized section out of just regular construction material — plywood, et cetera. Once these appeared to fit together, we broke down the components that had to be detailed out and got to work."

Jein decided to try and match the internal design style of V'ger with the style that Apogee had already completed on the exterior — a shape that was full of details but muted by resin that was poured over it to smooth out some of the harsh angles and give it a more organic look. He hit upon a means of producing a great many detailed shapes in quick succession. "We took pieces of plywood triangles cut to exactly the size we needed, and we appliqued on different details. We used about two dozen *Battlestar Galactica* cylon base star kits for the basic triangle motif that carries on throughout V'ger. And we used a toy called Ramagon to get another sort of alien look. We also glued on quite a few pounds of Scotchlite beads — very fine glass beads — to give us some organic-looking polyp-type shapes on the surface. We used a lot of other things as well. When that was done, we sent the panels off to the Paramount staff shop where they made plaster molds and then fiberglassed quite a few dozen copies of each one — they came back looking like giant pieces of beef jerky or burnt pizza or something. Each one was about three feet by three feet

TAFT BLDG
OOSEVELT
HOTEL
EQUITABLE BLDG

ROOSEVELT
HOTEL

HOLLYWOOD
HOLLYWOOD

by two feet."

Next, Jein and his crew made an overall frame for the V'ger structure out of two-by-four stock, and then tacked the fiberglass skins on top. The result was an eight-foot-tall hexagonal shaft — twenty-two feet long — made in four breakaway sections. Three-foot plexiglass domes were installed in the center and one-foot domes at the tail. "They were supposed to be something like energy storage units in the original concept, I believe. There were going to be lights behind them, so we sandblasted the insides to make it more diffuse. Then, for the elongated window shapes, we put down small strips of tape in vertical and horizontal patterns. Occasionally, some of the guys would get carried away and the tape patterns would come out looking like words. When that was done, we spray-painted the domes — first with a silver paint that was very opaque to seal out the light, and then with our basic V'ger gray. Then we peeled the tape away to clear all the windows. They actually wound up looking kind of like computer readouts — which wasn't too bad as far as the design goes. But what V'ger really looked like when it wasn't lit was a whole series of geodesic Mayan or Aztec ruins. The details on the sides of the pyramids actually begin to look like temple carvings. I was thinking at the time that we ought to take pictures of it — Erich von Daniken could use them in his books."

It was the lighting, however, that proved to be the major problem. The domes were fairly straightforward — backed with colored gels and ten kilowatt spots, they produced the desired result. However, Trumbull wanted a multitude of tiny light sources scattered throughout the miniature. "Some of the fellows on the production previous to us had designed circuit boards that were going to produce the lights using something like grain-of-wheat bulbs in repeating, undulating patterns. We tried them on one section, but they looked awfully big and they ruined the scale." Jein suggested that fiber optics be used in a last-minute crunch, and once again the pattern shifted and approximately twenty miles of fiber optics were painstakingly installed. "Everybody was just sitting in corners, polishing fiber optic ends, drilling holes and shoving them in. It was like working in one of those fun barrels at the fun house. People were walking along, clinging to walls and putting in the optics and doing touch-up work — but being very careful not to destroy anything by stepping through it. It was quite a bizarre sight, and it got pretty frantic at the end. We spent about three or four days on it — forty-eight hour days."

In addition to the practical lighting on the ship, additional Scotchlite beads had been applied while the basic V'ger paint job was still wet, as reflective point sources. "We just threw them on by the handful. For weeks afterward, people were still slipping and sliding around on them — pulling them out of their hair and teeth. But the only way we could get them up there was to throw them. Not to say that the V'ger was randomly designed by things we were throwing at it, but there was a degree of that."

The whole of V'ger, from start to finish, took just over four weeks for Jein and his crew to complete. "We called people all over town. There were probably close to twenty or thirty of us working on it, on and off. At least four weekends we didn't go home at all. When it finally came out, we were still two or three days late."

Once V'ger was completed, there was still the hexagon bridge surrounding the V'ger site to contend with. "We got quite a few samplings of hexagonal metal stock, beveled the top edges, and sent them off to the staff shop to be cast. They made thousands of them in plaster, and we laid them out on a board in order of diminishing sizes."

Ever since the start of *Close Encounters* four years earlier, Greg Jein's life had been absorbed in back-to-back projects and murderous deadlines. Now, as *Star Trek* was drawing to a halt, he thought he was due for a rest. But in fact, he was about to come full circle: Steven Spielberg had decided to produce some additional footage for a "Special Edition" reissue of *Close Encounters of the Third Kind,* and he wanted Jein to work on the new miniatures — including the never-before-seen interior of the mothership.

Once again, Greg Jein moved immediately from one job to the next. His first involvement with the "Special Edition" came in the summer of 1979, when his crew constructed a miniature forced-perspective terrain — a glimpse of the Indiana countryside, complete with utility lights stretching off into the distance and a tiny replica of Roy Neary's truck about to be overtaken by the shadow of a flying saucer.

The next, much more major undertaking was the research, construction, and photography of the *Cotopaxi*, an American cargo ship presumably lost in the Bermuda Triangle, which mysteriously reappears a half-century later — in the Gobi Desert. The sequence had been cut from the original shooting script because of time and money, but was now restored.

The first problem was finding a picture of the *Cotopaxi* to work from, since exhaustive searches through innumerable libraries had failed to produce even a single photograph or drawing. Their quest eventually led them to the General Services Administration and the Naval Institute, where a photograph of the *Cotopaxi*'s sister ship was at last uncovered. In the meantime, however, Jein had located an old 20th Century-Fox prop ship that seemed suitable for the period it was to portray. Spielberg liked the basic design, so they began work on it. "When we finally got our cable photograph of the *Cotopaxi* sister ship, it was completely different. But we figured if anyone has to go to that much trouble to find out we're wrong, then more power to them. Actually, ours is much more handsome than the original."

Only the hull of the twenty-nine foot prop proved salvageable. From the deck up, it was constructed entirely from scratch using plywood and plastics embellished with miniature lifeboats and other props. When the *Cotopaxi* was finished, it was hauled out into the California desert near Death Valley. Spielberg chose the location because it was very barren — like the Gobi — but blessed with fine crystalline sand that would help enhance the scale. The

Jein and his crew were also responsible for building the twin-engine Beechcraft and P-40 pursuit plane which engage in a low-level aerial dogfight over Hollywood Boulevard. The scale-model aircraft were then mounted on wire flying rigs and propelled down the street at speeds approaching fifty miles per hour. / Prop maker Don Hathaway and Greg Jein adjust a miniature searchlight. / William Fraker sights down the Hollywood Boulevard set as model and effects crews make last-minute preparations for a shot. Jein's efforts on behalf of 1941 *earned him his second Oscar nomination in three years.*

miniature freighter was positioned in the desert setting and then photographed from carefully chosen angles to cheat the natural perspective and make the ship appear immense in comparison to the apparently nearby — but actually distant — helicopters and jeeps investigating its discovery.

Back at the studio, Jein's crew worked on other supplemental scenes, including new miniatures to augment the original "Quarter-Pounder" shot. Spielberg wanted to linger over the scene a little longer, so an insert was added from the saucer's point of view, showing the billboard in greater detail. "We went to McDonald's, bought a half dozen burgers, touched them up with glycerine and coloring, and photographed them." The photographs were then enlarged to fit the new one-by-two foot billboard, which was a good deal larger than the original one which stood only about three inches high. As a gag, the original billboard had featured a hamburger orbiting the earth, with the words "It's Out of This World" printed beneath it. Appropriate as that might have been to a science fiction film, someone pointed out before the "Special Edition" construction began that the same slogan was actually the property of the Carl's Jr. hamburger chain. So the sign was promptly amended to read: "Next Exit, Turn Right." For all the special attention, the insert passes relatively quickly. Most of the time in construction was spent in producing the one-sheet, pasting it up and aging it so a section of the sign is falling apart. That, and of course, adding the essential detail to the scene.

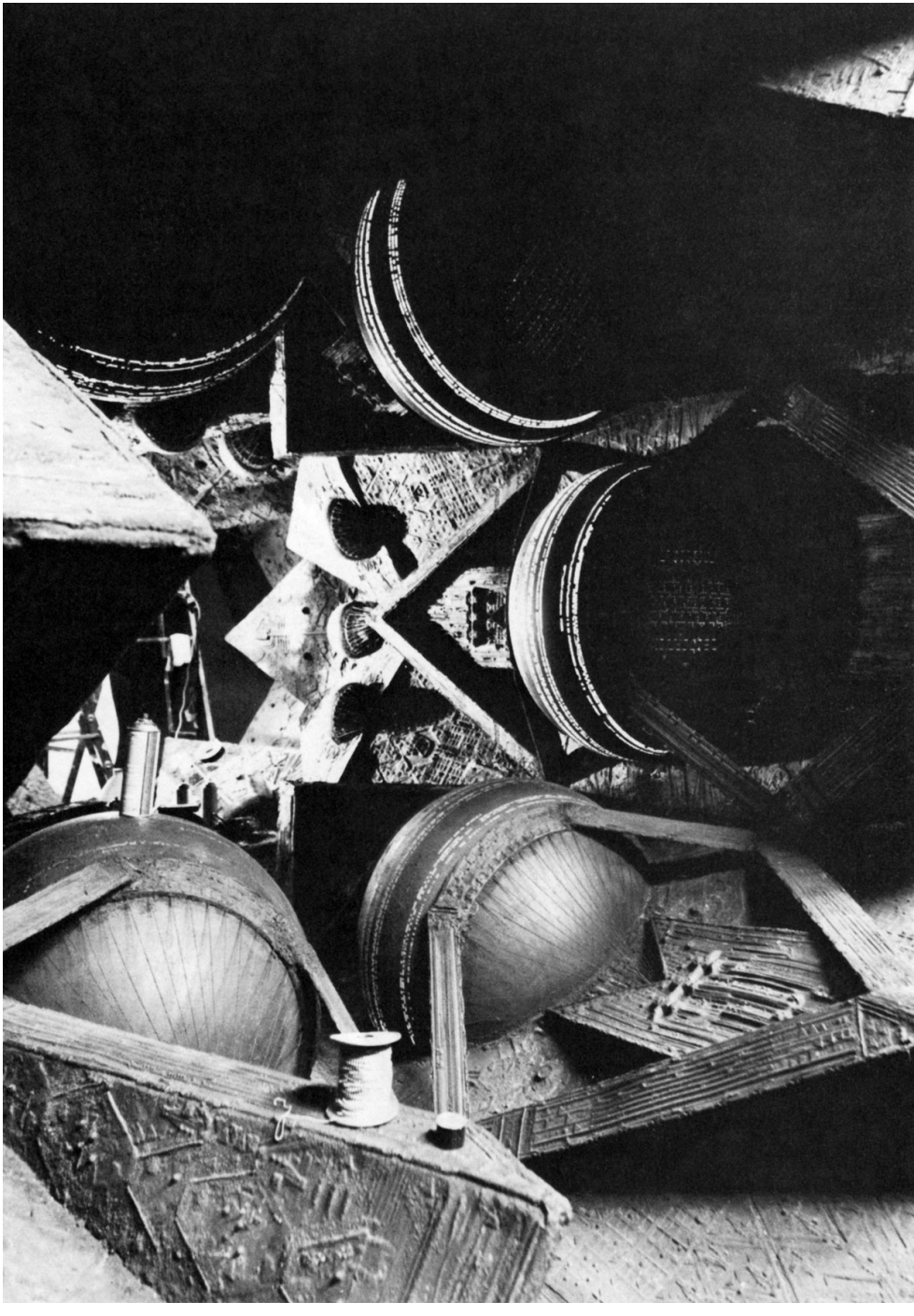
Jein likes to spend roughly half his total work time on detailing, and even something as fleeting as the "Quarter-Pounder" scene is no exception. "There are a lot of innocuous things around the billboard, just to increase the reality of the setting. We even had little crushed Coke cans and litter all over the ground."

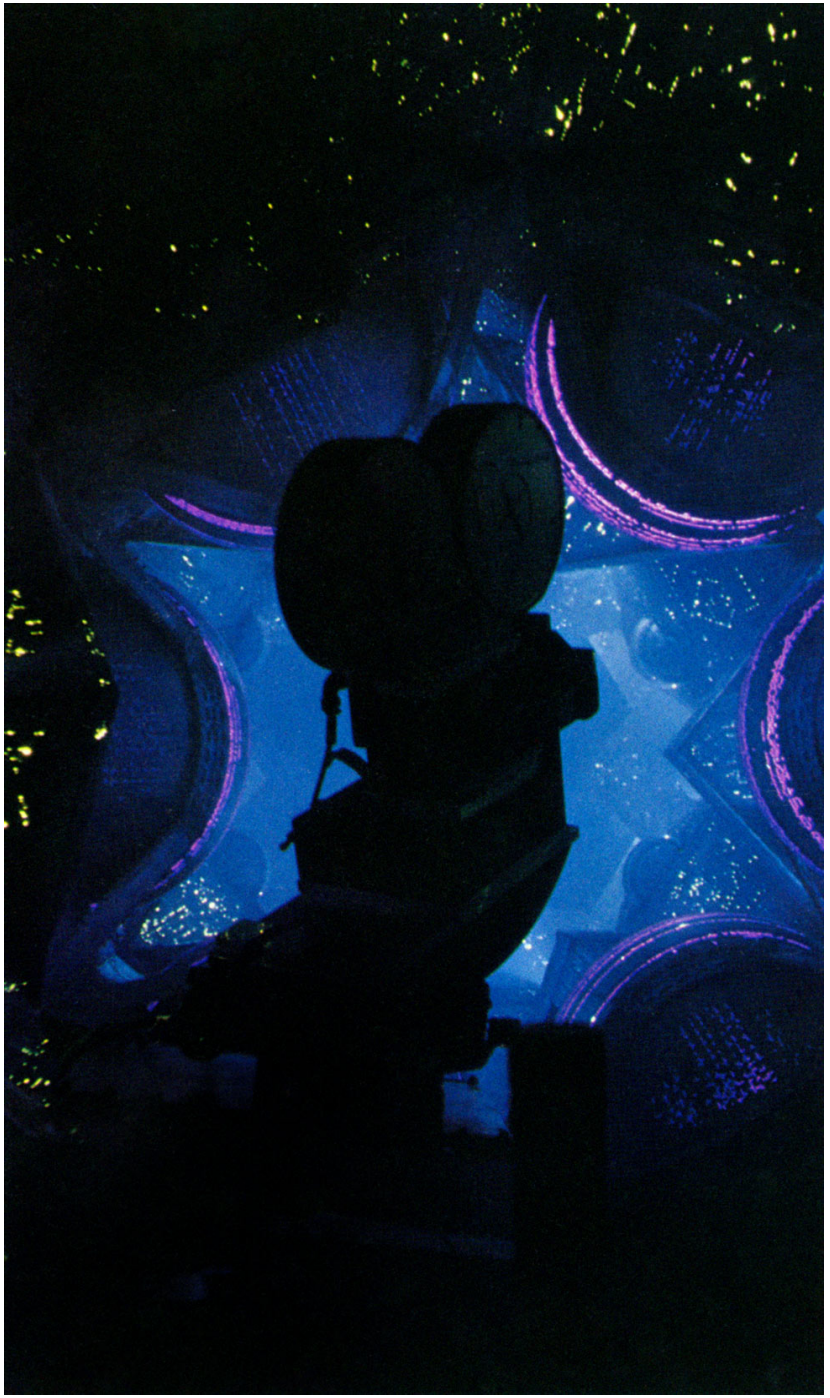
How long does it take to produce a miniature crushed Coca-Cola can for a sign that's only a foot tall?

"About as long as it takes for me to drive from my house to Olvera Street and to go to the notions shop where I buy keychains that have miniature Coca-Cola cans on them. A lot of times we'll do that. For a lot of detailing, I rely on things from dollhouse stores. Even if they're out of scale I can use them, because assuming you catch a glimpse of it at all, you're more likely to think, 'Hey, I know what that is!' than you are to think, 'Wait a minute, that's not the right size!' "

Greg Jein's biggest challenge for the "Special Edition," however, was the construction of the interior of the mothership. The concept had been developed by Ron Cobb, who had faithfully carried over the ship's exterior contours and motif to the interior design. "It was really a very functional design — like a dished amphitheater at the bottom. Everything was divided mystically into sevens — seven corridors, seven hatchways, seven repeating facets. As your eyes go up towards the ceiling, you go from a dark, mysterious area to an area of light — like the center dome of a cathedral. Then, suspended from the center dome is a huge power core that all the saucers link up to. It's like standing

Paramount executive Jeff Katzenberg and Star Trek *effects supervisor Douglas Trumbull study Greg Jein's mock-up for the V'ger interior. On the floor are the initial stages of the "space lips" miniature used in the Spock spacewalk sequence. / In a remarkably tranquil moment at the model shop annex, Jim McGeachy peels tape strip windows from the painted plexiglass domes within the V'ger miniature. Textured fiberglass panels were produced in quantity and nailed onto a four-piece wooden framework. / Jein and assistant Robert Short demonstrate one of the lighted domes for Trumbull. / Brett Webster threads fiber optic elements into the V'ger model. Some twenty miles of fiber optic material were used throughout. / The finished miniature — eight feet in diameter and twenty-two feet long — took four back-breaking weeks to complete.*





in an architectural Carlsbad Caverns. Neary is tremendously dwarfed by everything — he's hardly more than a fleaspeck."

Drawing on lessons learned from the frantic V'ger project, Jein and his crew first prepared a number of detailed surface shapes which could then be reproduced in whatever quantities were needed. Styrene was used for the basic patterns, because as a nonporous plastic, bits and pieces of detail could be glued on easily and the smooth surfaces required only minor finishing.

"We just made the prototypes at our own shop, and then had the parts fiberglassed and tacked onto a wooden framework. I had some of our senior crew building the framing structure, and a second crew detailing the fiberglass panels. Then the electricians came in and put in all the lights. Actually, it was a pretty fast process."

Once again, Jein and his crew applied their standard trademarks to the highly detailed interior. "If anybody's real sharp, they might see that some of the dark alcoves and recesses have little tableaux we put into them. One of them has two little cows in a pasture; another has a plane crashing between two palm trees, from *1941*; another one has Regan levitating over her bed from *The Exorcist* — a few other things like that."

The worst of the gags by far involved a small and relatively innocent rodent. "The studio is plagued by mice — it's *always* been plagued by mice. On *Close Encounters*, some of the guys would throw dead mice on top of Devil's Tower as a joke. Anyway, one day we found this dead mouse by the matte camera, so I made a cap for him and put him at a little desk. Other guys added little collars and cufflinks and things like that. But then, a couple hours later, he disappeared." The mystery was resolved, however, when the model crew came in one morning to find that the "Seaview" section — like the exterior, the interior was area-coded with specific names — had suddenly sprouted two little mouse paws at the front and a tail at the back.

Thousands of fiber optic light sources were installed throughout the miniature, and more than five hundred fluorescent units were used to illuminate the windowed acrylic tubes which hung from the ceiling. No one, however, was enthused at the thought of repeating the painstaking drilling procedure they had employed on the original mothership. "Instead, we drilled master patterns for an aluminum jig. Then we got some very thin sheet plastic, drilled through it using the jig, painted it black, and wrapped one sheet about each tube, taping it on the backside. It was much easier on the drill bits — not to mention everybody's patience."

The full model was fifteen feet tall and twelve feet wide, and took nearly three months to complete. Roy Neary — represented by a tiny figure from a *Space: 1999* Moonbase Alpha model — was a trifling half-inch tall by comparison.

Jein also supervised construction of a larger-scale miniature depicting the entry room where Roy Neary first beholds the inside of the alien vessel. "We got a little servo-actuated remote control doll — about six inches tall — and I spent a couple of hours sculpting a real quick Richard Dreyfuss mask that we stuck over the armature. Through the camera, you can see there's a little guy moving, but it's not close enough so you can make out his face. I could have put Jimmy Durante's head on it for all that matters. But it all ties in, because as the shots progress through the scene, Neary seems to get smaller and smaller as more and more of the ship is revealed."

Greg Jein's work on the *Close Encounters* "Special Edition" came to an end in the spring of 1980. Although last-minute additions were still being made months later, Jein turned those subsequent taskings over to his highly capable crew, limiting his personal involvement to that of a consultant. Determined to take a long overdue respite from his work, he declined several projects, turning his attention instead to leisurely activities and his long-neglected collection of movie models and technical memorabilia.

In recent months, however, his work has continued in abundance on the screen. *The Day Time Stopped* featured a modernistic desert home which he reproduced in miniature for some of the special effects sequences. Jein's work for that low-budget Charles Band production, originally filmed as *Vortex*, was completed on weekends and evenings during the early days of *1941* — before weekends and evenings ceased to exist for him. Then, during a four-month period spanning the last days of *Star Trek* and the start-up of the *Close Encounters* "Special Edition," Jein found time to produce two nine-foot nuclear submarines for the multimillion dollar Japanese disaster film, *Virus*.

After only a couple of months of relative inactivity, Greg Jein has accepted his next major assignment — to produce an array of military aircraft for the forthcoming Clint Eastwood production of *Firefox*. Primary among them is the fictional MiG-31 — an ultra-advanced prototype fighter with thought-actuated armament and a sophisticated radar masking system that makes it virtually undetectable. Special effects for the elaborate chase which dominates the second half of the film are being produced under the supervision of Douglas Trumbull.

In the past half-decade, Greg Jein has produced a body of work that would stupefy most technicians twice his age. His contributions have helped advance the field of special effects by establishing new standards of excellence for movie miniatures. Whatever they are, his future projects can be expected to be even more challenging — with results that will be, without a doubt, stranger, stronger, and more amazing than ever before.

Brad Munson is an editor, writer, and broadcaster based in Santa Barbara, California. Graduate of the Radcliffe/Harvard course in publishing procedures, he is currently the editor of Santa Barbara Times, *a monthly city magazine, and creative director for an advertising agency. In addition, he writes and produces a daily humorous book and movie review program for local radio that is currently being syndicated. His first novel, a science fantasy called* The Mad Throne, *was published in 1979. He is now at work on a series of detective novels.*

Douglas Trumbull adjusts the lighting on the "space lips" miniature — one of several bizarre structures seen fleetingly during Spock's revelatory spacewalk. / To enhance its scale, the V'ger interior was filmed in a dense smoke environment. Thousands of fiber optic light sources were used throughout, and rectilinear patterns were introduced by shining spotlights through colored gels placed behind windowed plexiglass domes. An articulated maw at the far end was produced by another miniatures unit and then mated to the basic structure.

Star Trekking at Apogee with John Dykstra

John Dykstra came into the public limelight with the release of Star Wars. *As supervisor of special effects for that landmark production, Dykstra delved deep into the fledgling technology of computer-controlled camera systems — augmented by every other optical trick in the book, and then some — to create a battery of effects sequences unprecedented since the unveiling nearly a decade before of* 2001: A Space Odyssey.

With a collegiate background in industrial design and still photography, Dykstra entered the film business in 1969 under the aegis of Douglas Trumbull who had established his own effects facility in the aftermath of his trail-blazing work on 2001. *Working first on Trumbull's video representations of* The Andromeda Strain *and later on design and effects photography for* Silent Running *— interspersed with numerous television commercials — Dykstra gained a thorough mastery of special effects. Taking a brief hiatus from Trumbull, Dykstra joined a University of California — Berkeley task force studying psychological reactions to filmed versus real experiences. He then went to work for Graphic Films on an IMAX presentation,* Voyage to the Outer Planets, *before rejoining Douglas Trumbull and his newly-formed Future General Corporation.*

In 1975, Dykstra accepted an offer from George Lucas to set up and head a facility of his own geared toward producing the extensive special effects footage required for Star Wars. *Industrial Light and Magic, as the operation came to be known, took a remarkably modest $2.5 million budget and parlayed it into an Oscar-winning array of dazzling opticals — probably the best special effects bargain since the original* King Kong. *Despite the mutual benefits incurred, Dykstra and Lucas parted company after* Star Wars. *Dykstra went on to produce and supervise the special effects for* Battlestar Galactica, *but withdrew after completing the first seven hours of programming when network officials decided to abandon the periodic telefilm format and plug the show into a weekly time slot.*

Under the banner of Apogee, Inc., Dykstra and his associates were then engaged to produce the elaborate effects for Altered States. *Budget escalation, however, prompted Columbia to put the project in turnaround. When it resurfaced a short while later at Warner Brothers, a new director and production designer had been hired and Apogee was no longer involved. The situation proved fortuitous, however, to Douglas Trumbull (1:4-33), who had just assumed the monumental task of completing two years' worth of* Star Trek *special effects in only eight months.*

How did your involvement in Star Trek *come about?*

We were looking for work, obviously. *Altered States* had fallen out, and since we were under exclusive contract to that project we had nothing else going at the time. Doug had just started actual production on the *Star Trek* effects, so he came out and we talked about the project and what had to be done. We ended up arriving at an agreement to split the load and work together, though somewhat independently, toward getting the picture finished in time. It took us a little while to refocus our efforts toward working on another big space show, because after *Galactica* we'd kind of set our motion control rigs and model photography stuff aside and gone into construction on the types of things we'd be needing for *Altered States,* which involved mainly optical effects and live action stuff on the sets.

Doug and I spent a lot of time talking about general concepts and what we could do with this sequence and that. With the time we had left we couldn't very well try for a whole lot of mystical new techniques. Instead, we had to use variations of techniques that already existed. The idea was to reduce the stuff to some common denominator and make it doable.

Oddly enough, this show used just about every format there is for the original taking photography. Most of the live action was shot in 35mm anamorphic, but a lot of what would later be combined with opticals was shot in 65. There was also some conventional 35 flat and some VistaVision. I think Bob Abel may have even shot some 16. So it was a real hodgepodge of formats. And that really determined to a great extent the division of labor on the picture, because Doug works primarily in 65mm and I work in VistaVision.

Also, since we have a bluescreen operation, we were given the stuff that tended to have more speed to the motion. Double-pass high-con mattes work fine as long as they fit; they just don't smear well. If you have any kind of speed lines or any kind of streak to the image, bluescreen will give you that smear. With double-pass mattes, it's real hard to get — and much tougher to control. Of course, for *Star Trek,* that turned out to be a relatively unimportant factor since there really wasn't very much smearing of any kind. In fact, all the moves were pretty ponderous — bordering on lethargic in some cases. I suppose that was inevitable with the *Enterprise,* but I really thought we could have gotten more movement into the Klingon sequence. It's not that I wanted things to whip around all the time, but I think everything was just a little bit too constrained. Our opening shot was about as wild as I was able to get on this movie, as far as doing anything with the camera. But at any rate, if there *had* been much in the way of speed in *Star Trek,* we'd have been in a better position to deal with it than Doug would have with his double-pass operation.

Bluescreen has it's limitation, though. Bluescreen becomes real problematic as far as surfaces that have any kick to them. You'll notice that most of the miniatures we shoot have matte surfaces. If you have a shiny surface and you get some reflected blue on it, it'll make a hole in your bluescreen matte. We had quite a lot of trouble with the live-action bluescreen stuff in *Star Wars* for that reason. So even though bluescreen is a pretty rote technique for us at this point — because we've done so much of it — it's not necessarily the solution to everything.

interview by
Don Shay

Star Trek — The Motion Picture *photographs copyright © 1979 by Paramount Pictures Corporation. All rights reserved. Special effects unit still photography by Mike Middleton.*

What, specifically, were your areas of concern on the picture?

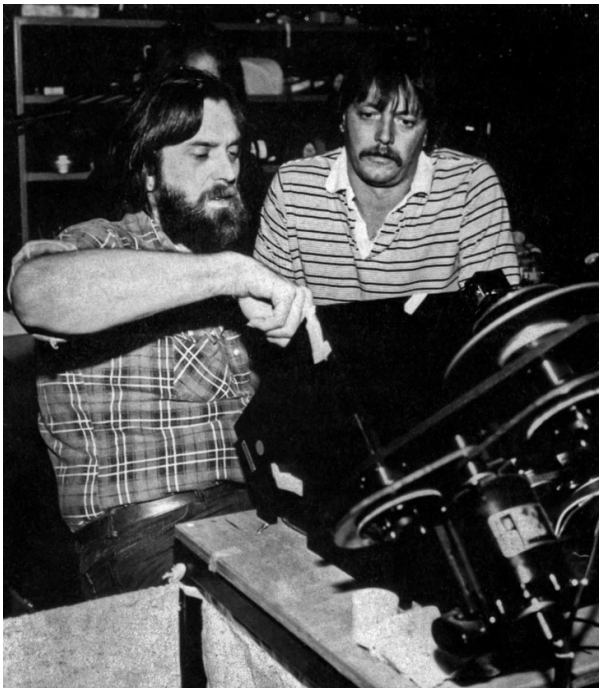
The first thing we worked on was the opening sequence of the Klingons versus the cloud. That whole bit was ours, except for the cloud itself which was generated over at Doug's place but composited here. Basically, the Klingon ship came to us as a completed model. Like the *Enterprise* and a number of other things in the picture, it was built by Jim Dow and the people at Magicam. We had to modify it pretty severely, though, because apparently it was not designed to be shot in the same kinds of circumstances that we ended up shooting it in. I don't know what Bob Abel planned to do with it, but for us, the practical lighting on the model was so dim that we weren't able to get a good exposure off of it even by pushing the film a couple stops and using a twenty- or thirty-second exposure. That was a real problem because we had a time limit; and oddly enough, it often comes down to just how long you end up having to spend on any given frame, especially since we were having to make six and seven passes to shoot these ships. Also, if you get too big an exposure range on your various passes, you end up having to change f-stops; which is not good if you're doing multiple passes because the size of the image changes somewhat when you change the size of the aperture.

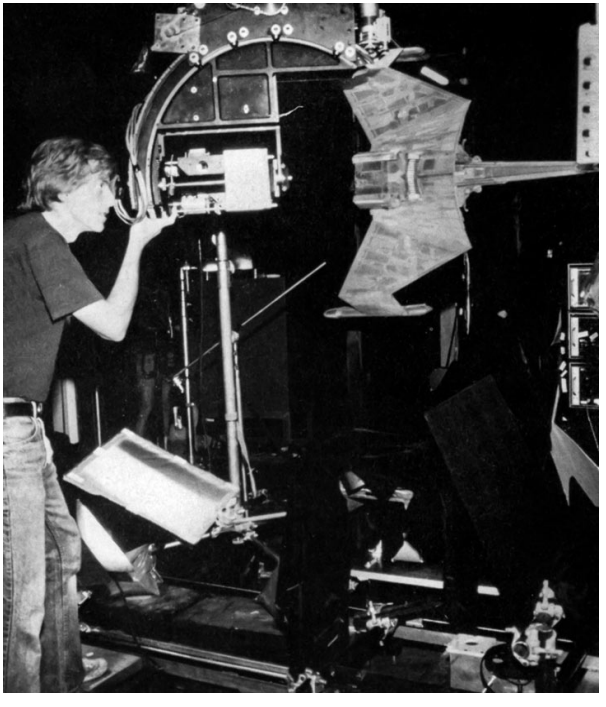
When you shot those six or seven passes, did you do your compositing in the camera?

No. They were all separate elements composited in the optical department. It was really an oddball combination of lighting. We had our basic setup for the shot, which had a relatively high fill ratio. That was in keeping, pretty much, with Doug's handling of the *Enterprise* shooting, which was designed to have enough fill so you could see everything. Then we had two, and sometimes three, separate passes for the various practical lights on the ship, some of which were shot with diffusion to achieve the engine effect. Those kinds of passes aren't usually too difficult to composite since they're just straight burn-ins. In some cases they don't fit properly, but normally you don't notice it that much because they're only lights. We used the one Klingon model for the whole sequence — all bluescreen composite combination, except for the opening shot which was a double-pass matte deal. We used two passes on that to get a high-con matte because we couldn't do the roll-over trick and keep the bluescreen behind the model.

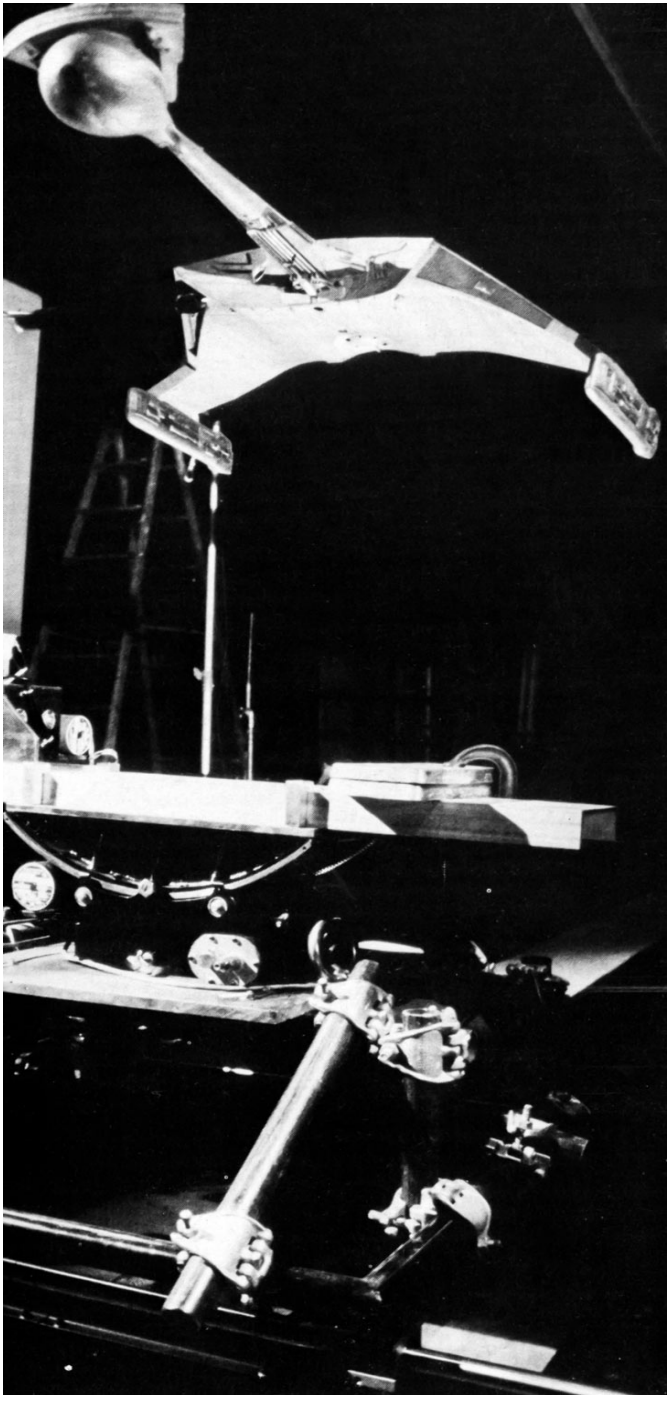
That was a really nice opening shot.

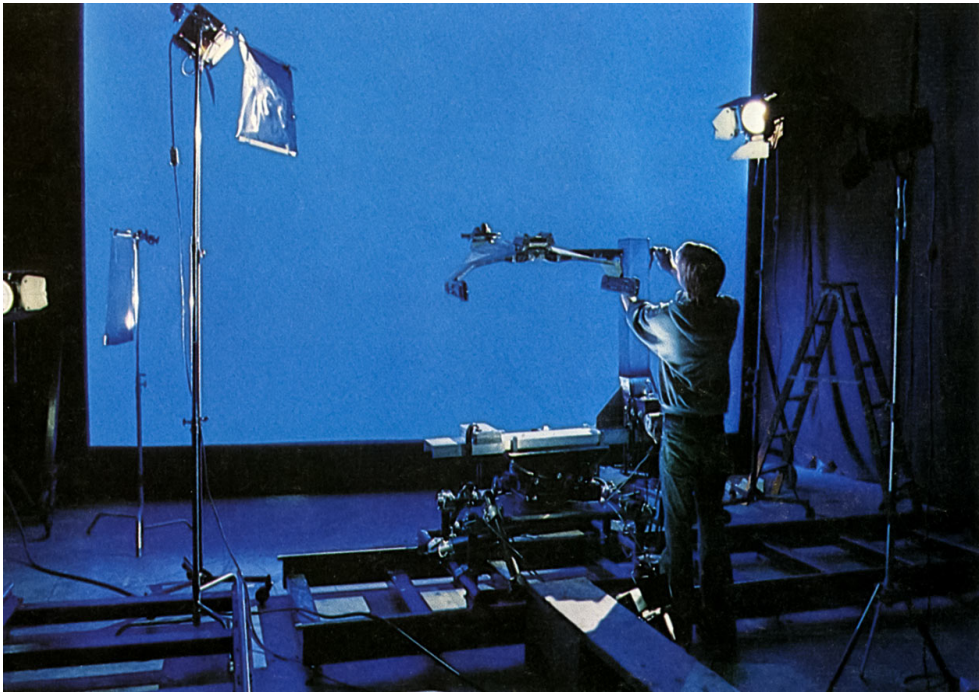
Doug Smith was pretty much responsible for working that out. The whole idea was to come up with something that was nice and yet unusual. People are always coming to us and saying they don't want an opening shot that looks like *Star Wars* — they just want something that has the same impact. Well, that gets a little tough after awhile. The *Star Wars* opener was incredibly dramatic. It showed you the scale and the size of those ships, and it gave you a sense of speed that you don't normally get in a space environment. So it's an effective trick, but it's since been overused. The idea with the Klingons was to give us the same kind of visual impact, but without doing a real close flyby.

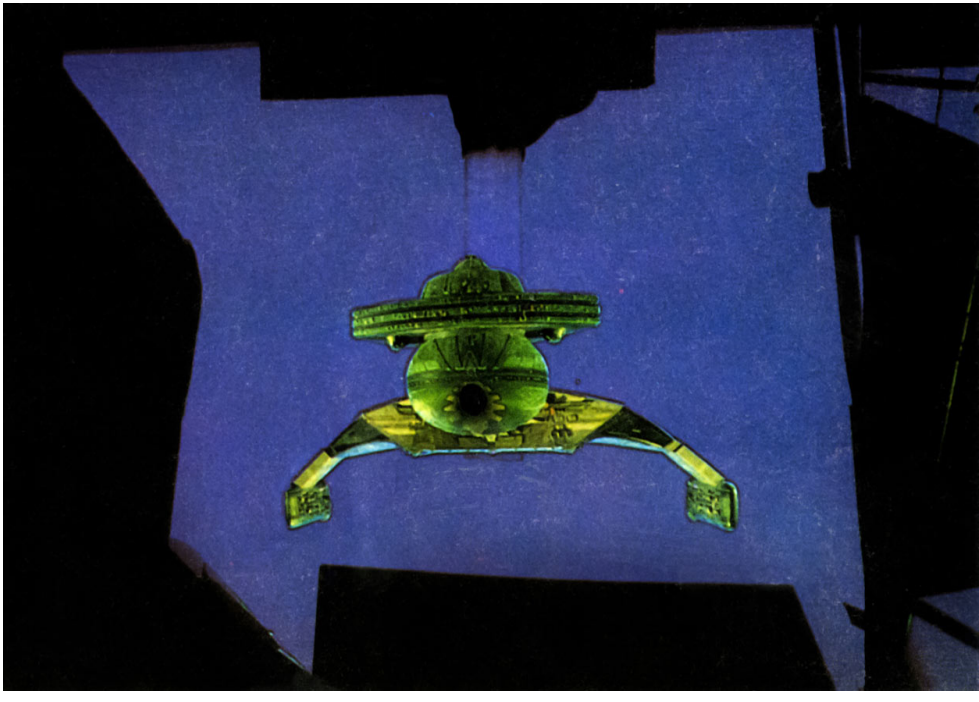


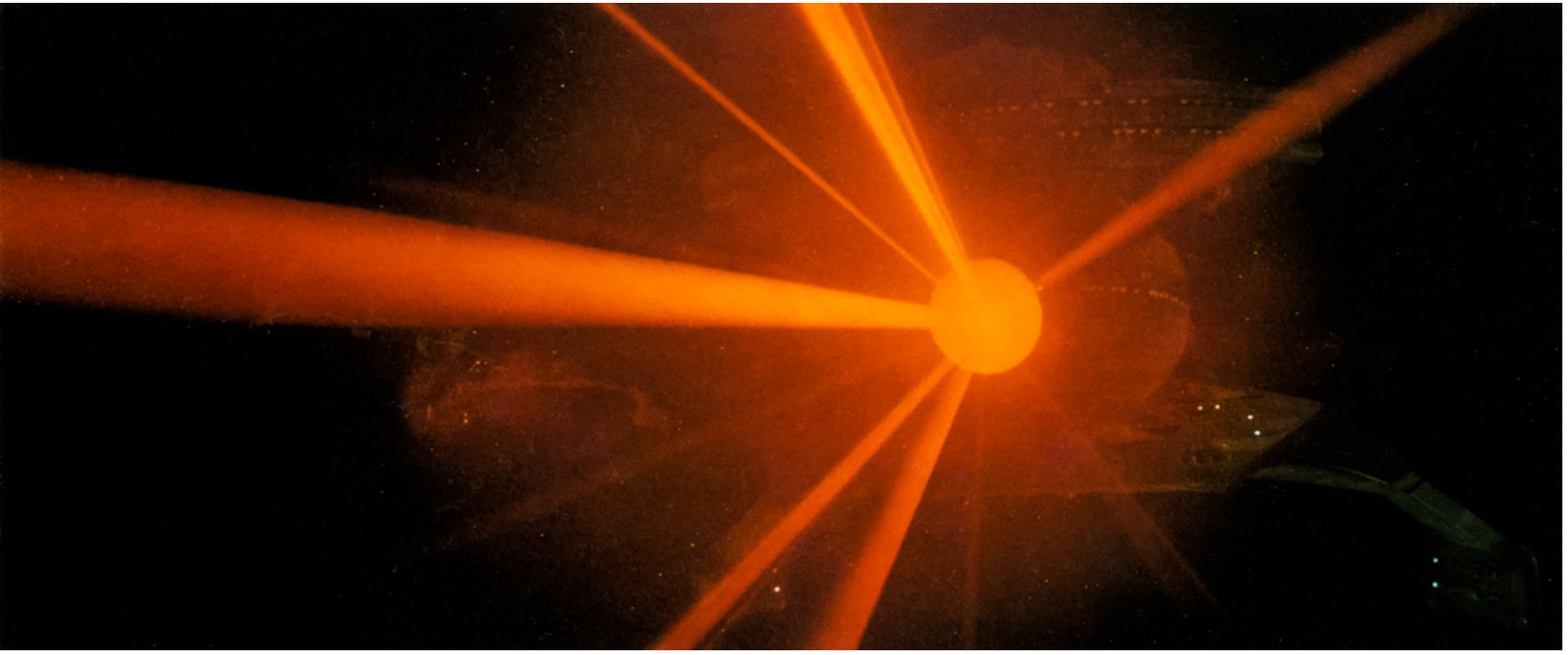


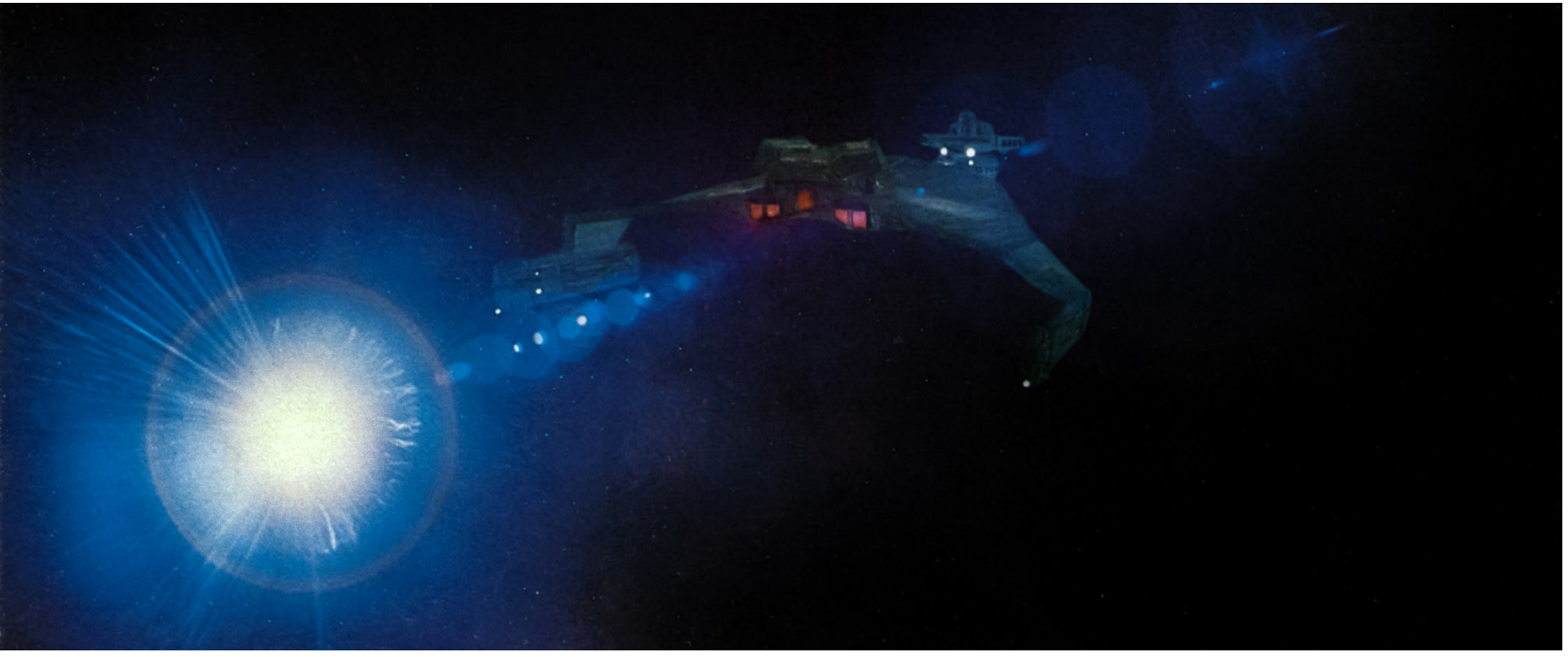
Special effects supervisor John Dykstra reviews composite footage with his director of optical photography, Roger Dorney. Approximately one third of the Star Trek *effects were produced at the Apogee facility. / Doug Smith programs the motion control system for one of the Klingon shots. A manually-operated control box dangling in front of the model activates the various channels of movement. / The Klingon ship mounted and ready for shooting. One model represented all three Klingon vessels. / A custom fluorescent bluescreen enabled the optical department to extract mattes from original photography so that as many as a dozen or more separate film elements could be composited together. A neon pylon — balanced in color to blend with the bluescreen — is used to support the model. / A bluescreen element as it comes out of the camera. The neon pylon is discernible, but blends sufficiently with the background to enable the extraction of a clean matte. Extraneous dark areas in the frame, representing light stands, deflectors, and other unavoidable obstructions, are optically removed with garbage mattes.*

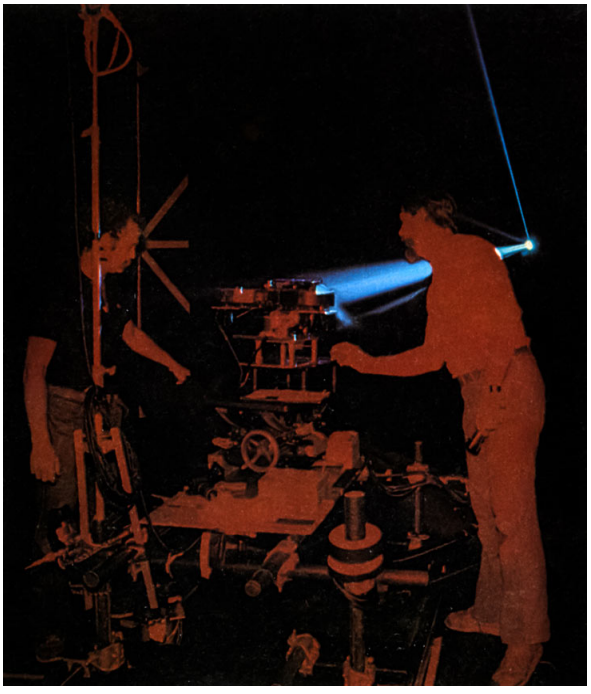












From there, we head on into the cloud, and that was one of the major interfaces that took place between our unit and Doug's, because essentially the cloud was flat artwork which was prepared down there by Bob Swarthe and his people. Since we were doing the Klingons and they were doing the *Enterprise*, our job was to shoot the cloud on our equipment so that it would match the stuff they were going to be shooting later on theirs; and actually, it worked out pretty well.

We shot all the photon torpedo stuff, with the idea being that the weaponry the Klingons used would not be significantly different from the weaponry on the *Enterprise*. We just changed the colors — the bad guys had red ones and the good guys had blue. The effect itself was put together by Chuck Barbee and John Sullivan and some of the guys down in the smoke room, and it was the first work we did with this one particular laser we have which is a monster twenty-watt job. We took a crystal — just a hunk of glass — and mounted it on the end of a rotating rod so that as the laser came up through the rod and into the glass it bounced around inside and sent shards of light flying off in all directions. Unfortunately, it picked up a lot of contrast as it went through the optical steps — which really can't be helped unless you do it in-camera; and that's virtually impossible when the effect has to be comped with ships and other things. As a result, it's hard to maintain any kind of a nice diaphanous edge to things. The final result still looks pretty good, though, and it has a lot of energy to it.

At any rate, once the Klingons open up on the cloud, the answering fire from the cloud — what we called the whiplash effect — was something that was basically put together by Bruno George, one of our optical guys. He came up with a way of combining in-camera a flare from a tiny xenon bulb and some very carefully controlled electrical discharges. It was strictly a move-shoot situation. First they made a pass on the bulb to get the flare; and then for the discharges they made a pass on a large Tesla coil.

The final effect looked like a sphere of light with little electrical sparks around the edges. Doesn't a Tesla coil normally arc from one terminal to another?

Sure, but if you put a ring around the discharge point, it'll spark to different spots on that ring; and if you leave the shutter open long enough, eventually it will fill in. We did a lot of experimenting with the Tesla coil — high speed and slow speed and all kinds of different things to see what effects we could get. It's really strange stuff. For one thing, we found you can't capture an arc halfway from one point to another — it's just instantaneous. The faster you shoot, the fewer strikes you get per frame; but basically where there *is* an image, it's a single-frame image. You can look at stuff that's shot at three hundred frames per second and other stuff that's shot at one frame per second, and aside from the fact that you're liable to have more arcs on the slower exposures, you can't tell the difference between the two. No matter how fast you shoot, none of the arcs carry over from one frame to the next. Another thing we found is that it's very dif-

One of the Klingon ships fires a photon torpedo at the advancing V'ger cloud. / The photon torpedo was produced in a smoke environment by directing a high-intensity laser beam into a revolving crystal, thereby creating shifting shafts of light. Cameraman Chuck Barbee (right) and assistant Proctor Jones supervise the laser photography. Klingon photon torpedoes were tinted red; the Enterprise *ones were blue. / The answering fire from the cloud was a combination of two elements — a motion control pass on a xenon light source to create the flare, and an identical pass on a Tesla coil to create a corona of electrical discharges. / Camera set-ups are seldom as clean as they appear on screen. Greg Kimble makes final lighting adjustments prior to photographing a scene.*

ficult to get any kind of perspective with the arcs, even if you put the Tesla coil as far away as you can and have it strike right to the lens. To look at the arc, you can't tell that one end is very near and the other far away. So there were a lot of limiting factors to the Tesla coil effects, and ultimately we ended up using a lot of animated lightning in other parts of the picture.

What kind of exposure time did you need to allow your whiplash discharges to fill in the circular ring?

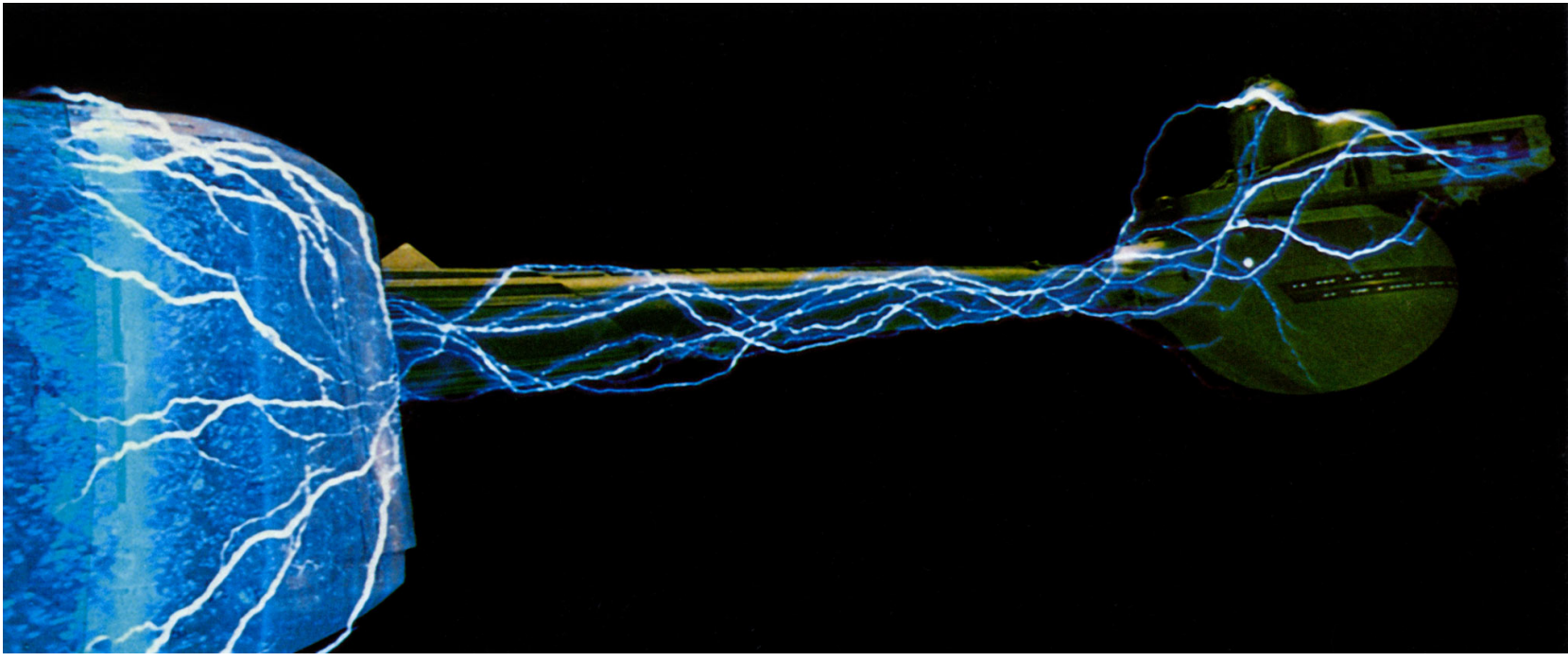
Something on the order of a couple, three seconds per frame. I'll tell you, that coil we've got is a big mother — it'll zap the living poop out of you. When it's tuned up, it'll put out a half million to three quarters of a million volts and can throw an arc up to about twenty-five inches in free air. If you put it in a helium environment, it'll go about six feet. The amperage is very low on the output side, but the voltage is incredible. And it's noisier than hell. We have it in a room that's completely surrounded with chicken wire — which makes kind of a Faraday cage for it — because basically it puts out a lot of high-frequency electromagnetic energy which could really do a number on some of the sensitive electronic equipment we have around here. Plus we covered the outside with black fabric to eliminate light problems — not from their light getting out, but from other light getting in — because the exposures were so long that any kind of ambient light at all screwed up the shot. So for the guys that worked back in that room, it was literally like being stuck in a dark cage; and they buried themselves back in there for quite a good portion of the production and got very crazy. At one point, they even got into making crazy slates. We'd be sitting there in dailies and these in-camera transporter effects would come on. One person would slate on and spin into view, and then he'd disappear and my dog would appear sitting on a chair going around and around. Then there'd be a handful of glitter and three people would show up with a broom and a knife and a fork. It got very nutty towards the end. Every day something screwy came up in dailies. But it was a release for these guys. With a half million volts of electricity flying around, I guess they needed something.

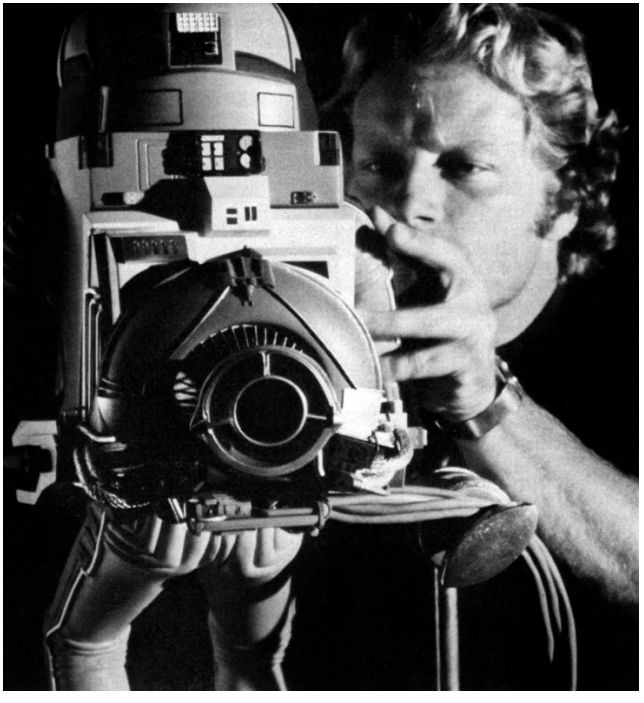
Tesla coils work on the basis of collapsing fields which reinforce themselves and build into these huge oscillating voltages of very low amperage. Because of the ratio of alternating current and very high voltage, Tesla coil discharges supposedly travel over a surface rather than through it. So theoretically you could grasp onto the coil itself and have the discharge come right off you, and it would be quite harmless. Of course, you'd have to make sure that you put some kind of a conductive gel between your skin and a metal surface that will act as the point at which you discharge. Otherwise, you could discharge off the tip of your nose — or off a variety of other promentories on your body — and when you did, it would burn a little hole in your skin. We did have one guy who got zapped in the belt buckle, but nobody got crazy enough to grab ahold of that coil and shoot arcs across the room.

Anyway, that was the alien's energy weapon. When it came out of the cloud and struck, it covered the Klingons with this electrical discharge which was generated in a similar fashion in that same environment. Then we went to a laser scan technique to create the disappearance, or digitization, of the Klingon ships. We used a smaller laser for that. It was five watts — which is still a pretty potent laser, but the problem is that when you start scanning it, you're essentially diluting the energy that it's putting out over a larger area and you end up with a limited amount of light. So the exposures had to be quite long. At first, we'd scan just a small part of the model; and then we'd increase the scanned area on each subsequent frame so that the digitization effect would appear to be sweeping over the ship. The lines start out far apart and then get closer and closer together as they move across the surface. Then at the end there's something like an arc — a brilliant, flaring light which is supposed to indicate that the ship's molecular structure has been reduced to raw information and consumed by the cloud. It's been destroyed, but in a more elegant way than just being blown up. It's violent and destructive, but the kicker — which you don't find out until later — is that the digitization is really a method of information storage. To get the effect we wanted, we had two, and sometimes more, scanning passes to build up the image. We scanned the model itself once; then we covered the model with foil and did another pass. That way we had a hard line for the initial scan and then a sparkling line following it. If the scan line wasn't coming out bright enough on one pass, we'd have to do a second. Then we superimposed the scanned footage over the footage of the model itself, which was also in movement at the time. So it was a pretty complex process, and the scanning device that made it all possible was put together on very short notice by Al Miller and his electronics crew. After that was done, Harry Moreau and John Millerburg and the people up in the rotoscope department made frame-by-frame roto mattes so the ship would fade out and disappear.

We spent a lot of time futzing around with lasers. In fact, early in the show I had the idea to use lasers as a sole light source in photographing some of the models. It was an idea that I originally planned to use for *Altered States*. In fact, we had gotten our first laser for that picture — a nice little krypton job which could emit all three colors of the spectrum. Anyway, in my farmboy approach to the thing, I figured that with this wonderfully coherent light source — parallel rays in phase, like the sun — we could scan an entire surface using the laser as a sole light source and end up with infinite shadow detail. Right? Well, yes — but it doesn't really work because it's so monochromatic that it starts doing some real funny things when you move either your subject or your camera. We tried shooting a model that Joe Garlington had done of the V'ger home planet, but we came up with some really strange specular problems. When you start to move, there's a phase cancellation. The very thing that makes holograms work is what screws lasers up as a light source for two-dimensional photography — and that is that the light itself is so critically in phase that when two phases shift relative to one another they cancel each other out and you get little dark spots. And the weirdest thing about it is that if you move the model,

A Klingon ship is engulfed by the digitization effect, generated by a laser scanning technique. Electrical discharges photographed from a Tesla coil were then superimposed over the basic imagery. / Effects cameraman Greg Kimble and John Sullivan prepare the model for the first phase of the laser scanning operation. / After the first scan, the ship was covered with foil and a second scanning pass photographed. The final result combined a hard scan line as the effect first sweeps over the ship, followed by a sparkling scan line from the foil pass.





these little spots start crawling all over it like a bunch of ants. I went into it with high hopes — until we saw the dailies. It looked like cheap solarization. So obviously, we didn't use it. But I like lasers a lot. They're really fun, and they'll give you an unusual effect. The only thing is they require a very sophisticated touch; otherwise they become pretty heavy-handed.

After the Klingon sequence we go to Epsilon 9, the floating space antenna which is overtaken by the cloud. Overtaken at Warp 7, I might add — which should have made the sequence very easy to photograph; because by the time they saw it, it would have been gone. I don't want to suggest that I have anything but the greatest of respect for people who are commercially viable writers and directors in this business; I just happen to be much more technological than most of them. So when somebody comes to me — creative, metaphysical person that I am — and tells me this cloud is traveling toward Epsilon 9 at Warp 7, it seems to me it's going to get there pretty damn fast. But that's not real visual, so we just suspend physics for awhile and try to make it *look* good. What the hell. I figure as long as nobody gives me any shit about having to make it *look* like it's going Warp 7, I won't give anybody any shit about what they call it.

Your people built the Epsilon 9 model?

Right. Actually, there were about two or three of them. There was the entire station which you saw from a distance in the early shots. That was about six feet long and three-and-a-half feet wide — and just unbelievably detailed. On top of that, Roger Dorney, our chief optical guy, came up with a way to pull bluescreen mattes off that sucker — which was really awesome. With all the latticework and stringers that thing had, the registration had to be *incredibly* accurate, and he came up with results that damn near exceeded the resolution capability of the film.

In addition to the basic Epsilon 9 miniature, we also had one isolated panel for the closer shots that was about five feet wide and six feet long. And there was a larger-scale version of the conning tower where we used straight rear projection to put the people in. We made an inordinate number of miniatures for this picture; and Grant McCune and the dozens of people he had working for him back in the model shop did just a phenomenal job. They were literally working around the clock, just days ahead of the camera crew. As one end of a model was being rolled onto the stage to be photographed, the other end was getting a last shot of spray paint. And the fact that they made those things work under those kinds of circumstances, and put the stuff together so they would last through the shots — but not by putting so much time into any one thing that it kept them from completing all the other stuff — well, it was just a miracle.

Another thing we did for the Epsilon 9 sequence was build a two-foot tall scale model spaceman that we had zipping around this way and that. Doug used it also in the drydock sequence and in the Spock spacewalk. David Sosalla did the sculpting, including the faces of Spock and the others who would be inside the suit; and John Ramsay worked out the mechanics for articulating the arms and legs. It was shot using motion control, and then we went back in with animation and added little blips of energy from the thrusters.

Essentially, though, what happens to Epsilon 9 was a replay of what happened to the Klingons — the electrical discharge material and the laser scan stuff. There were a couple nice shots that didn't get into the film, where the puppets are being chased by the destruction in a different way than we've got them appearing now. But we ran out of time, and weren't able to get them to go together right.

Was that a problem you had very often?

I wouldn't say often, but there were a number of shots that would have been very nice that just didn't get into the movie because of lack of time to do the combinations or lack of time to reshoot a tricky element that didn't quite work. Everybody was employing as much ingenuity as they could, but even ingenuity can't solve *all* the problems. We had a really nice thing involving the asteroid that gets caught up in the wormhole with the *Enterprise* toward the beginning of the picture. The idea was that they were going to blast it with their photon torpedoes, and it would shatter into a million pieces and bounce harmlessly off the ship's force fields. But the asteroid deal suffered severely because the wormhole sequence was one that I don't think Bob Wise was ever quite satisfied with — not the interior stuff; that was great — but the exteriors. As a result, it was one of the things that ended up getting worked on and worked on and worked on until everybody had exhausted their enthusiasm for coming up with a solution that would satisfy Bob's requirements and could be executed in the time that was left to do it. But we went ahead with this asteroid thing. We took a rock that was about twelve inches in diameter at the center, and broke it all up into pieces. Then we cast all the pieces in foam, reassembled them back into the rock shape, and loaded it up with all kinds of garbage — diatomaceous earth and glitter and explosive charges — all kinds of stuff. Then, since we needed to shoot straight up at it, but didn't have enough ceiling height, Gene Polito shot it for us on a rented sound stage in Culver City. In fact, we used up about half the electricity in the whole city because we needed an incredible amount of light for the high-speed photography and for the rim-lit effect we were trying to get. All together, I think we blew up about three of those foam rocks.

Did you wind up having to shoot very much that wasn't in the film?

Not very much. I don't know what our shooting ratio was on the original photography aspect of the thing, but it wasn't particularly high — maybe three-to-one, or something like that. And mostly it wasn't a matter of stuff not being used because it was bad, but rather because we were dealing with very complex concepts. Take the asteroid for example. I mean that thing wasn't just a little old rock blowing up. It was a rock blowing up inside of a wormhole with a force field. And in fact, we had some *great* looking stuff of those rocks flying by — probably the best zero-gee stuff we've ever done. But to get the combination of

McCoy beams on board the Enterprise. *The swirling reintegration effect was accomplished by photographing glitter with various distortion effects and then masking it to the proper image size with rotoscope mattes. The transporter beam itself was achieved by laser-scanning a rotating wire to obtain a tubular light effect. / David Sosalla sculpted a miniature spaceman puppet that was used in the Epsilon 9 sequence and later in the Spock spacewalk. Spock and Kirk heads were interchanged as needed. / To actuate the puppet, John Ramsay devised a remote-controlled mechanism that was fully articulated and capable of being linked into the motion control system.*

that to work with the wormhole effect, which at first was okayed and then it wasn't okayed, was a real problem. Roger Dorney somehow managed to pull contrast mattes off all these rock pieces, which in itself was amazing; and then Harry Moreau and his people in the art department dressed it all up so the holes that were in some of the mattes were eliminated. But there was no way to get enough of a handle on the whole shot and really mate all the elements so you could cheat this one a little bit one way and that one a little bit another way and do all the tricks the optical guys do to make the shot come together. One of the big problems was the point at which the rocks hit the shield and vanished. That was all done with roto mattes, and unfortunately it just wasn't very convincing. Since there wasn't enough time to go back and finesse it to the point where it would compare favorably with the rest of the shots, we had to scrap it. I think it ended up just being a straight DX (double-exposed) explosion.

So there were a few of those kinds of things, but not many. For the most part, everything worked. Everybody was putting out a hundred and fifty percent. Denny Kelly, who was head of the editorial department, was essentially taking the material right from Doug Smith and the guys on the stages, sitting down with the storyboard, putting the footage together, and then giving it to Roger Dorney in optical — and Roger was making this stuff come out. As a matter of fact, he had about a one-and-a-half to one shooting ratio on his composite work, which is incredible considering the number of elements. Many, many of the shots came out on the first try — which was not only phenomenal, but also fortunate, because there just wasn't time to go back and keep working the composites over and over until we got them right.

How many optical printers did you use?

Four — two aerial heads and two bench printers. Each shot was assigned to one particular machine, from generating its elements to actually putting it together. Theoretically, you ought to be able to use one machine for separations and another one for something else and a third one for the composite itself; but by doing that you run the risk of swapping idiosyncracies. By doing everything on the same machine, any aberrations in the optics, or elsewhere, will appear the same on all of the elements; so supposedly everything should still fit right. Unfortunately, though, that theory doesn't always work out.

Why is that?

The success of any composite is almost strictly a function of operator skill — plus a lot of luck. Beyond that, you have to have mechanical magicians constantly waving their wands over the sensitive equipment. We were fortunate in that regard to have Dick Alexander and Don Trumbull. But even with a top-notch optical and mechanical crew, luck is still very much a factor because there are things that you simply have no real control over. We do color separations here. Well, any time you generate black-and-white material from color material — even if you do it in contact, negative against raw stock, and you use colored light to separate — you end up with, depending upon the exposure and the development, a slightly larger or slightly smaller image than you had before. If you overexpose and underdevelop, the image is going to be slightly larger; if you underexpose and overdevelop, it's going to be slightly smaller. It won't be larger or smaller by much, but when you do critical matting on things like hair or things that are spidery or things that occupy only a small part of the frame, that difference in size can be really significant when you consider the entire format. There are a lot of aspect ratio variables, but if you take standard 35mm four-perf film — which is about an inch wide — and project it onto a forty-foot screen, you have a magnification ratio that's close to five hundred times the size of the original photography. So if your film image is off by only a thousandth of an inch you're already talking about a half an inch by the time it gets to the screen.

Now let's look at the film stock itself. Acetate-based film shrinks — there's just no way of getting around it. Mylar-based film doesn't; but original taking film normally isn't mylar, because mylar doesn't snap. If you're using mylar in a specialty camera and the film jams, the camera will generally break before the film does. So we use acetate. Because of the shrinkage factor, Kodak only guarantees plus-or-minus 2/10,000ths of an inch. You can't do any better than that no matter how accurate you are in your development, careful handling of the film, and all that stuff.

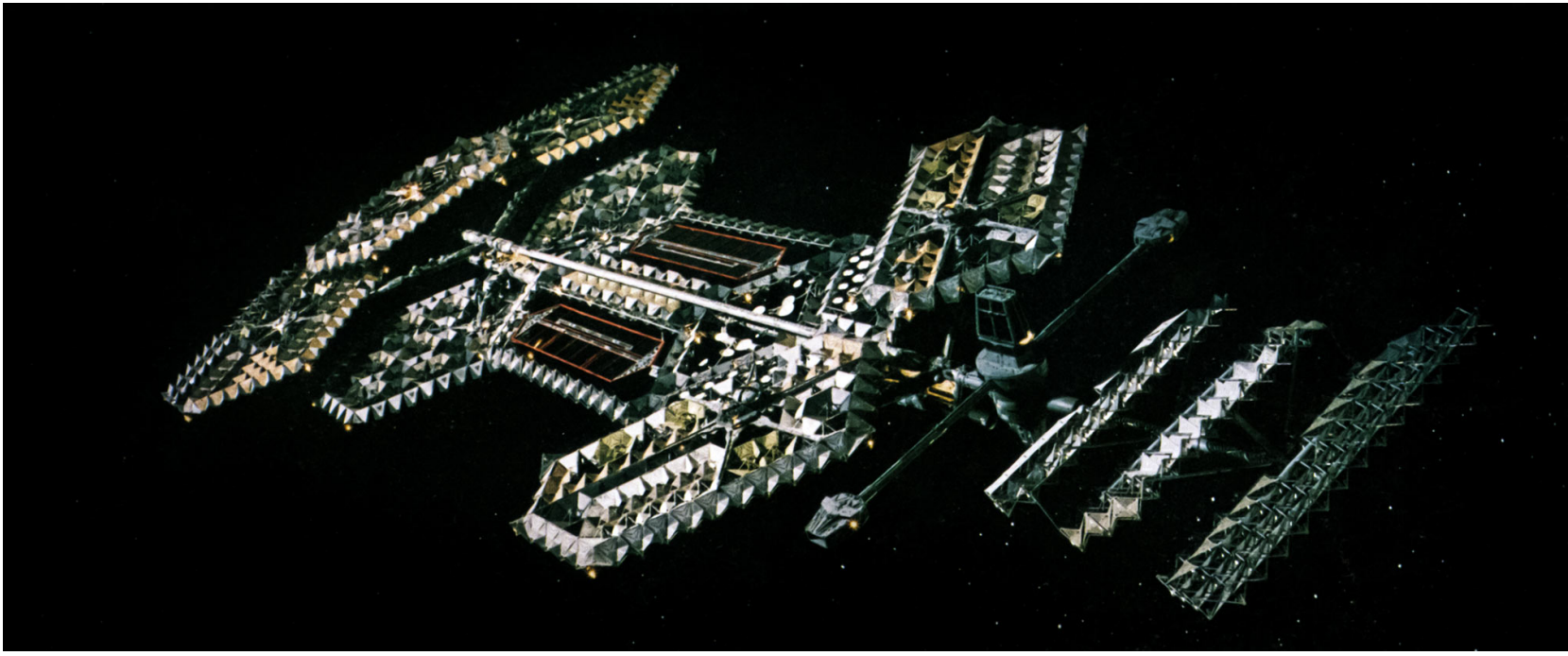
So you have fluctuations due to exposure and development, plus any aberrations there might be in the lenses, plus that 2/10,000ths of an inch. Add to that the fact that you're combining maybe thirty pieces of film in every composite, and you end up with a situation where a half-inch matte line on the screen is really pretty good. But you might just as easily end up with three inches. There's just no real way of telling until you run it through the system. If by some miracle, everything shrinks and swells and goes back and forth the same way, it might even come out perfect.

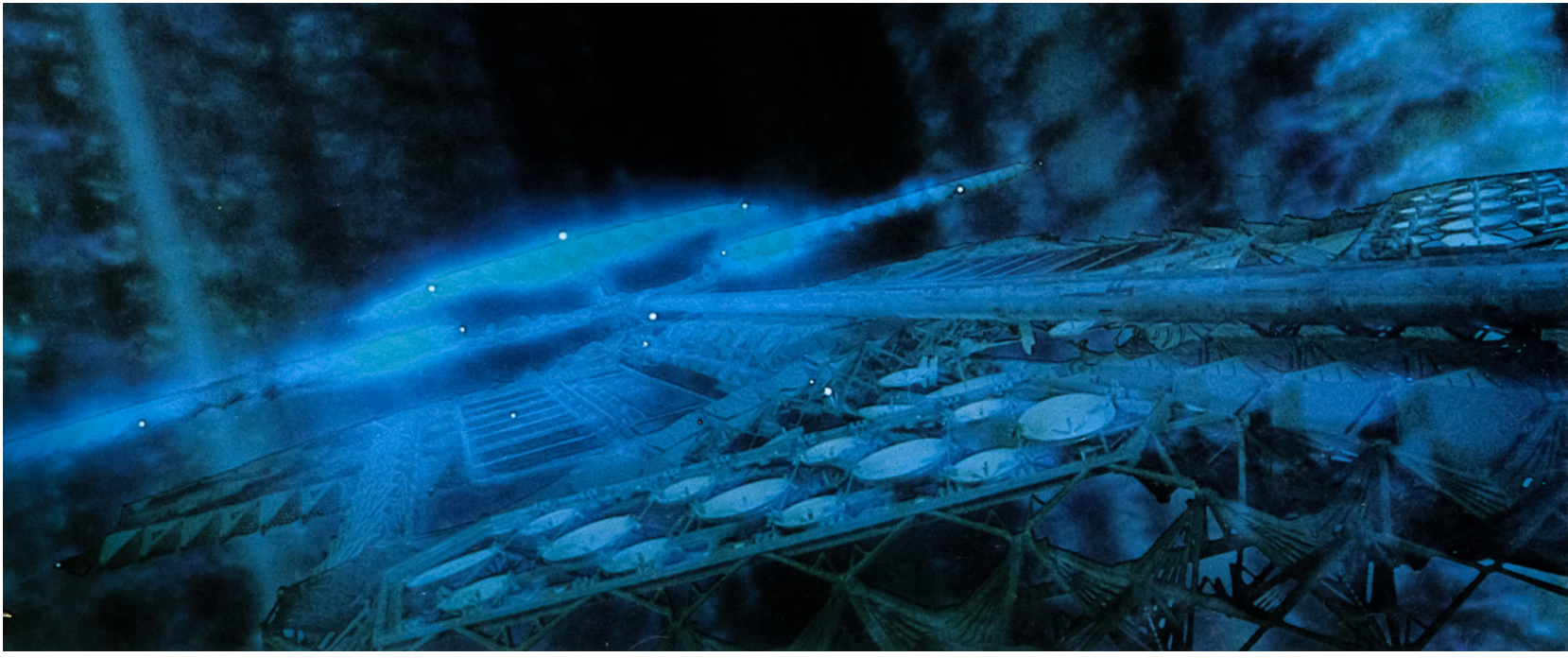
These are the kinds of things that even the very best optical operators have to deal with, right off the top. You have to know that going in. But it's the end result that counts. Will the shot fool your eye, or won't it? Precision is a given. You have to be incredibly precise — period. If you're not, you're never going to make a good shot. But on top of being precise, you have to know how to cheat. You have to be able to sit down and pick wedges and guess at exposures; you have to know when to do a sync lap on two pieces of film in order to get rid of a hard edge when it appears; you have to know when to use a thin holdout matte because you've got bright background and foreground subjects; you have to know when to make the density of a particular matte higher or lower to achieve a particular end — it's a matter of literally massaging everything all the way through. And it's as artful a craft, easily, as original photography.

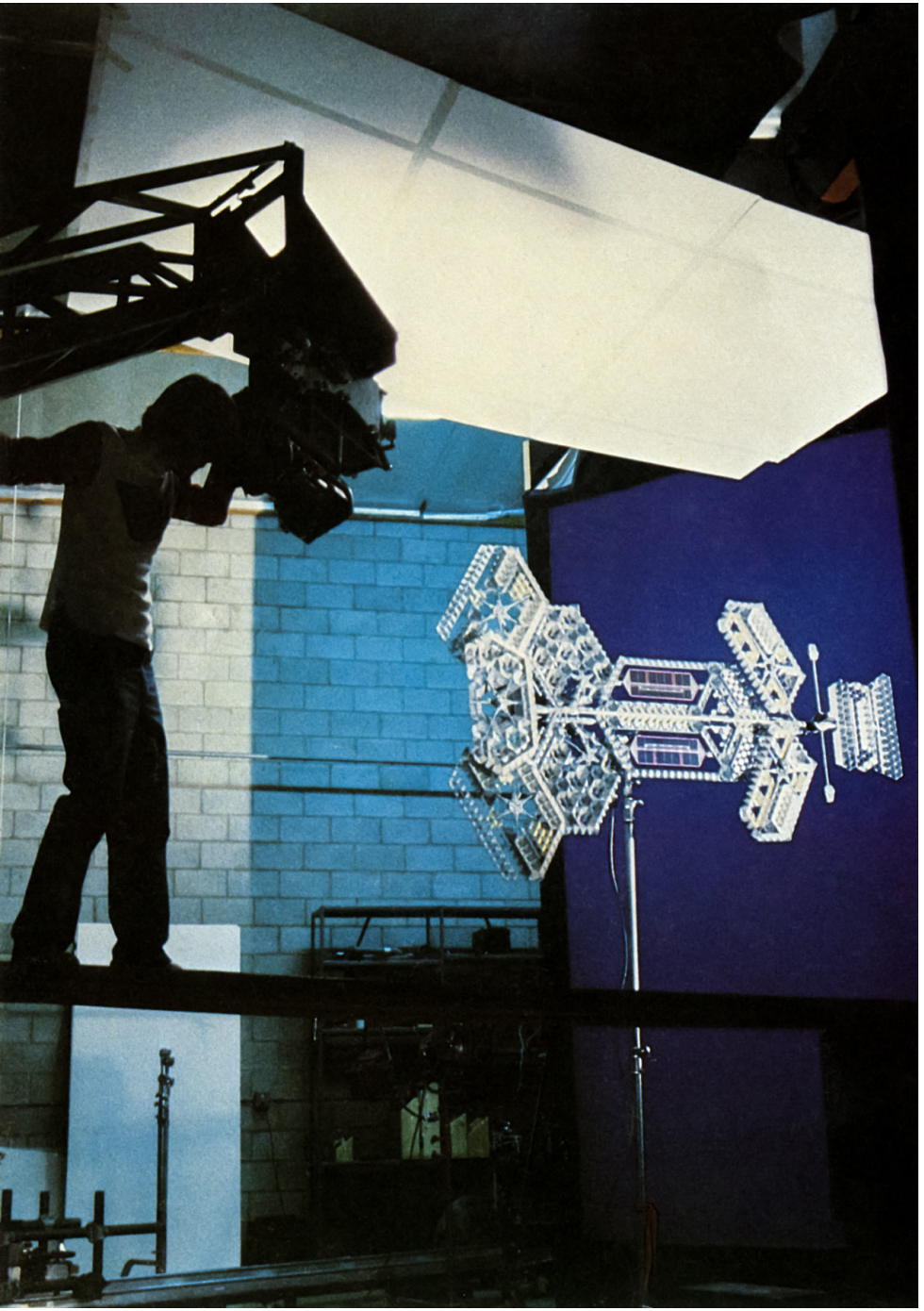
Are there ways the operator can accurately predict his results, or is it subject too much to uncontrolled variables?

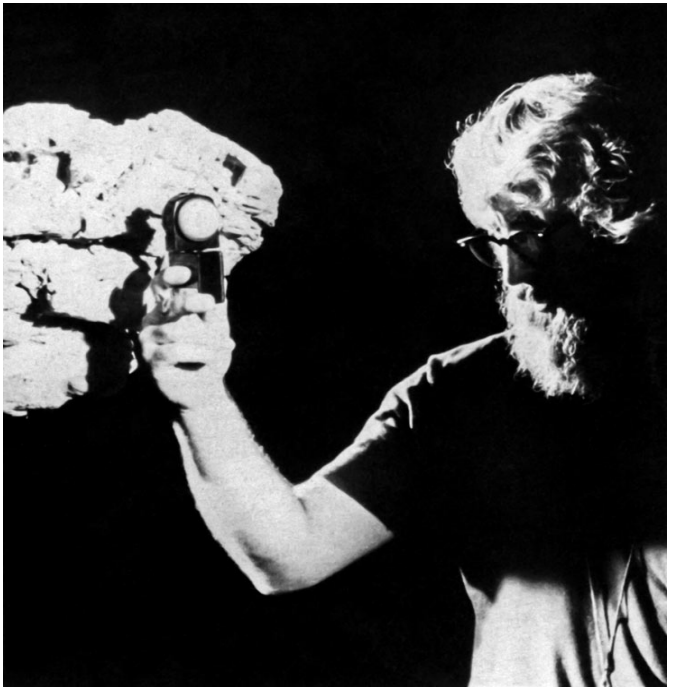
Oh, sure. He can run the mattes with the foreground pieces to

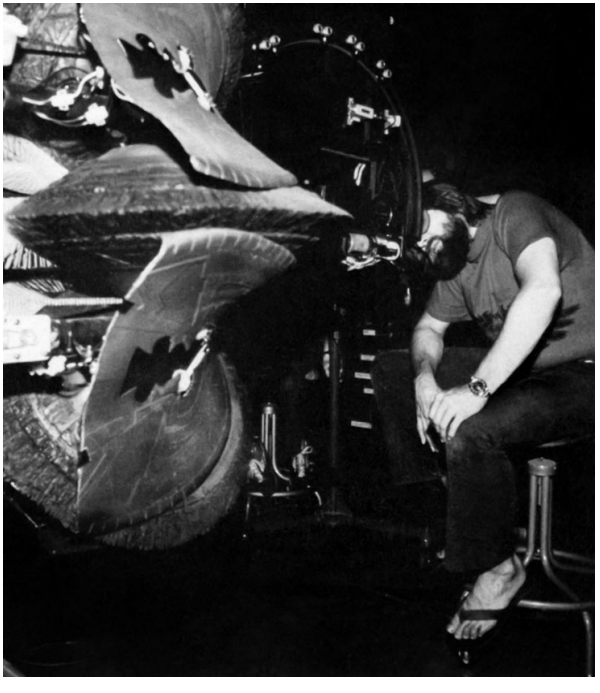
Reports on the alien intruder are relayed to earth from the deep space station, Epsilon 9. A six-foot miniature, constructed by Grant McCune and his model shop crew, was used for the long shots. Larger-scale sections of the station were built for closer angles. / Overtaken and devoured by the V'ger cloud, Epsilon 9 was photographically digitized employing techniques similar to those already devised for the Klingon shooting.











see if they basically fit; he can do trial composites where he'll put maybe two of the Klingon ships together rather than all three; he can use compound holdout mattes which combine four or five mattes from four or five different moves onto one piece of film to cut down the number of film runs and cut down the accumulated increase in density. There's a whole bunch of things he can do preliminary to making the final composite. But if he's gone through the steps often enough and has the techniques down cold, then a lot of those little trial steps are just a waste of time, because there's really nothing he can do preliminary to the making the final composite that's going to determine for sure whether the final composite is going to work. Basically, he just has to apply all of his accumulated knowledge and then just *assume* that the thing's going to fit together. If it isn't right it's got to be reshot, so you might as well put the damn thing together and see what you've got. When you have a show like *Star Trek* and everybody's already working twelve to fifteen hours a day, there's just no time for the test-and-see approach.

What else did you do in the picture?

Well, let's see. We got into doing a lot of viewscreen stuff — God, did we do a lot of viewscreen stuff. One of the more interesting ones was fairly early in the picture when Epsilon 9 is biting the big one and Captain Kirk and the folks are watching it on the rec deck. We took some of our Epsilon 9 footage that was essentially already cut together and made a video tape of it, and then took it over to the guys at Vidtronics. What we were looking for were some nice bizarre video distortions — sort of an interference effect that didn't look like conventional video rasterscan static. And they — with the help of a friend, Dan Brewer — did a really nice job of giving us what we wanted as far as making distortions look video, but nonvideo. At least *I* thought so. Probably a lot of people just figured it was a bad comp.

But we did scads of viewscreens and general graphics pieces which are scattered throughout the picture. Some of them were done with bluescreen; some were black and had to be rotoed; some were in moving shots and had to have articulated rotos done on them; and some of the closeups used a separate model insert screen.

When the *Enterprise* finally gets to the cloud, we used the same kind of whiplash energy bolt as we had in the Klingon sequence. The *Enterprise* shields withstand the first bolt, but an electrical discharge slips inside the ship and zaps Chekov. That involved a lot of hand animation stuff that Harry Moreau and his people did. Anyway, they spray Bactine on Chekov's arm, Spock manages to broadcast the friendship code just as they're about to get zapped again, and then we're off into the interior of the cloud.

That's where the nightmare began. Poor old V'ger had a tough time being born. It had been conceptualized only in the broadest sense when we came on the picture. We knew it was supposed to be *big* — and that was about it. Bob Abel had done a study model in clay, about four feet long, and it looked something like a modernized *Nautilus*. Everybody was kind of pessimistic about

Cameraman Michael Lawler programs a down-angle bluescreen shot. The spindly nature of Epsilon 9 made matting a difficult challenge for the optical department. / David Beasley and Grant McCune piece together the intricate superstructure of the free-floating outpost. / Effects gaffer Chuck Embrey takes a light reading off a miniature asteroid used in the wormhole sequence. Several of the breakaway foam asteroids were rigged with explosive charges and filmed at high speed to simulate pulverization by the Enterprise *photon torpedoes. Time constraints and matting problems, however, forced the abandonment of the concept, and a superimposed explosion was used instead. / With Syd Meade's concept drawings in hand, Grant McCune briefs his staff on their most ambitious tasking for the picture — building the massive V'ger spacecraft. / John Dykstra lines up a shot of the V'ger maw. Designed by Ron Resch and constructed by Apogee, the intricately engineered mechanism irised open and closed as the petals rotated.*

the thing, and we tried fiddling around with it for a while, but it just didn't seem right. So we got together with a guy that Bob Shepherd, my production manager, and I had wanted to work with for a long time — Syd Meade. Syd's a conceptual illustrator — one of the best there is — so we contacted him, told him in general terms what we wanted, and he said sure he'd like to do it.

V'ger turned out to be the one thing in the film where almost everybody got to make an input. We all sat down and discussed it — Bob Wise, Gene Roddenberry, Doug and I. It was a true collaborative effort. But it was Syd Meade who made the whole thing work. After we all talked at great length about what it should be and shouldn't be, Syd went off with this ethereal description and came back with some concepts that were just magnificent. One of Syd's strengths is that he can come up with something that is elegant and beautiful and bizarre, but has a very definite functional reason for being designed the way it is. In other words, his designs make sense. We wanted a giant organic machine, and what he gave us was indeed something that had an organic logic to it even though it was constructed in a machine-like way. It *is* an organic, mechanical form — seventy-eight kilometers long — with an opening at one end for assimilating information, and a hexametrical form in the middle with energy-generating towers, and a brain case area to control everything — and it all ties together. When you look at it up close, it's a mass of rigid materials — tubes and links and ball sockets. But when you look at it from a distance, it looks like a muscle; and it's capable of the same kind of contraction, in a mechanical sense, that a muscle has in an organic sense. Plus it's regenerative. It has skin characteristic to it. The outside surface is very rigid and protective, but as you come to the orifices and the areas which are shielded somehow from the normal rigors of life you find surfaces which are somehow more alive and more full of whatever its life blood is.

And your miniature shop built the model?

Yeah. The whole model was sixty-eight feet long, and Grant McCune and his guys put it together in seven major pieces. They finished the back end first, since that's the first you see of it in the film. That way, the camera crew could begin shooting on the tail section while the model shop guys were building the next part up. So the model was quite literally being shot while it was still under construction. Fortunately, we could get away with that, because by the time the *Enterprise* enters the cloud and discovers V'ger, it's really too close for them to be able to see the whole thing at once. So that worked out rather nicely. We did actually string the whole model together when it was finally finished, but you never get a full view of it in the film.

What was it made out of?

You name it — just about everything from wood and plastic to foam and macrame and styrofoam cups. It had reflective lights and incandescents and strobe lights, and also some neon. It had rear-projection screens and front projection material; and it had oil spread all over it. Just about anything you can think of ended up on that model.

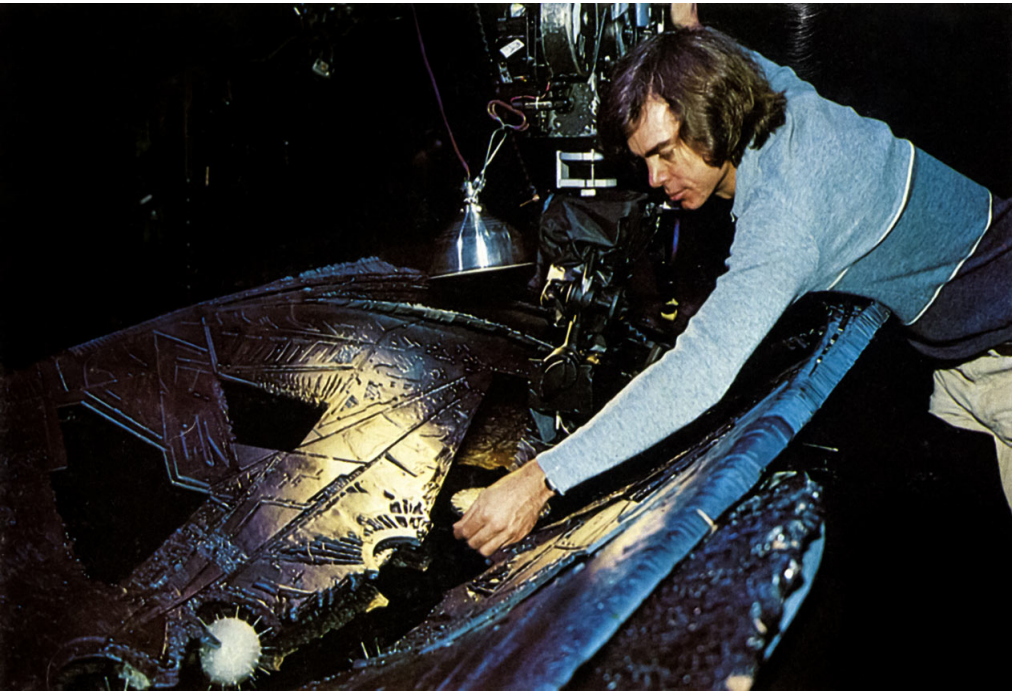
The V'ger model was constructed in seven sections and then transported to the Apogee annex where the main stage had been established as a smoke room. Camera crews began around-the-clock shooting on the model even before it was finished, working their way up from the tail to the maw and adding onto the miniature as subsequent sections were completed and transported to the stage. Model shop crewmembers Richard Smiley, Pete Gerard and David Scott work with cameraman Chuck Barbee to prepare one of the more elaborate V'ger sections for photography.

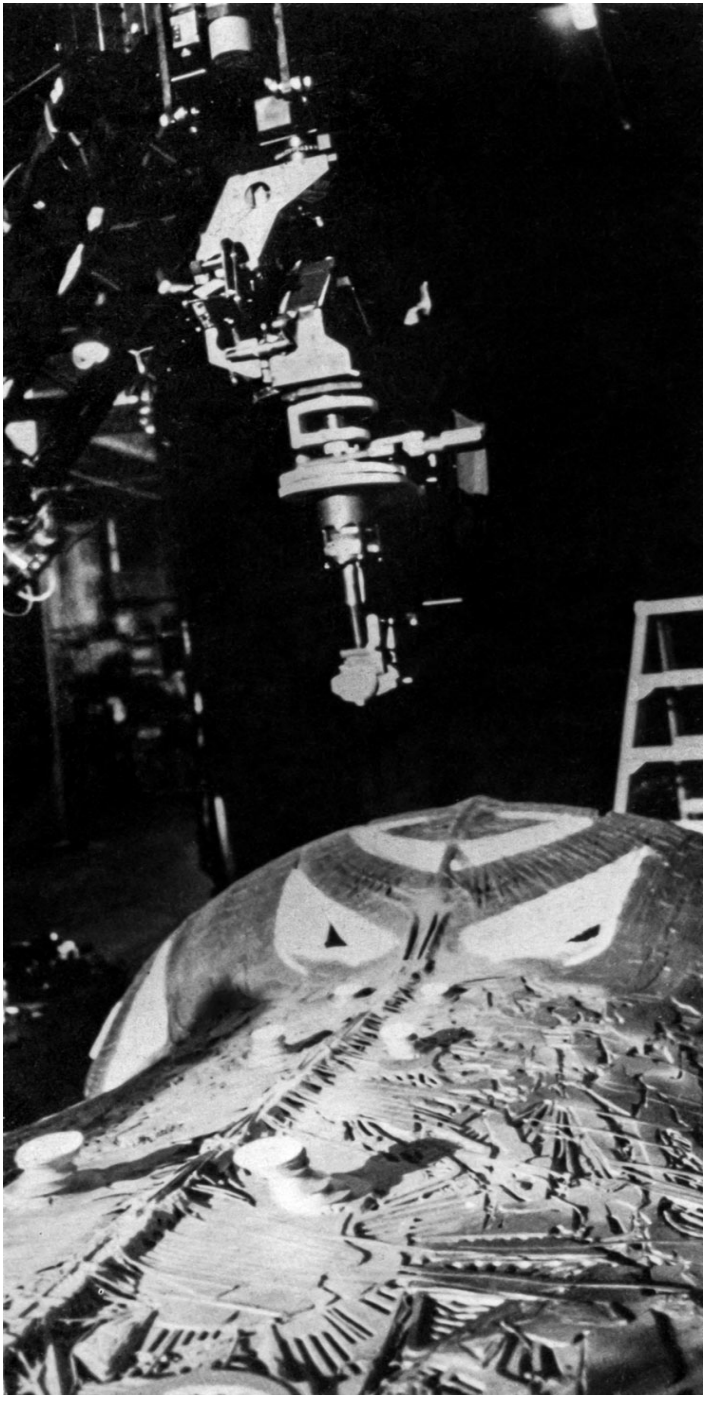
We had two crews working day and night shoting V'ger at our annex down the street where the smoke room was. Poor suckers had to work in that noxious environment — it was really vile. But we wanted the fogged atmosphere to create a forced aerial perspective and make the thing look really big. Also, the fog prevented you from seeing the whole ship at once, which was critical since we were well into shooting before the model was complete. Most of those shots required seven or eight passes — sometimes nine — and they were all put together in-camera because we were down to the wire on the printers. We were literally using every camera we had to composite. Normally, I would have preferred to shoot the elements on separate pieces of film and combine them in optical, because you have more control over the variables and can make adjustments; but we were just too backed up. I'm sure some of those shots could have been improved in the printer, but there are others that might not have looked as good since we'd have had to go another generation. So it's a trade-off. We'd have had trouble doing bluescreen on that model anyway, since it was painted a dark blue and it's tough to pull bluescreen mattes off blue objects.

But I'll tell you, compositing those shots in-camera was pretty hairy. There was no time for research and development. The guys spent about a week figuring out a basic method for shooting V'ger, and then just went to it. There'd be a pass which was top-lit with the fog off; then a top-lit pass with the fog on; then a pass in the fog with no lights on, but with a laser scanning those weird cloud formations overhead; then another pass to shoot the practical lights that were built into the model; and still another pass with strobes to put shafts of light into the fog. Then a lot of the shots had passes on painted highlights which were lit from the other side; and then maybe a pass or two on some Tesla coil effects which were rear-projected into the model. They did complex wedges on all these passes, but there was an awful lot of calculated guesswork involved. We had exposures that ranged from a half second per frame on one pass to 128 seconds per frame on the next. It was really weird. They'd set up a twenty-nine hour shot, do a quick black-and-white test pass to check the move, and then sit back and hope like hell that when the shot came up in dailies it was going to be all right. And usually it was — which is really something when you consider how unique and different most of the sections of that model were, and yet the overall sequence still had to have consistency and continuity. I tell you, by the time that whole thing was done, we had some real walking zombies around here.

The swirling cloud formations overhead were done by laser scanning the smoke?

Right. And that in itself required several passes to build up a suitable image since we were shooting at twelve frames per second in order to get the movement of the clouds and create scale. We used our big twenty-watt laser, which is really powerful. In fact, I don't think you can even license to buy one legally anymore. It could burn a hole in a door, or a tee shirt, or whatever else happened to get in its way — and did. Everybody





had to wear protective goggles, because if the beam kicked off a surface and into your eye, it could blind you. So it's no toy. And even though we didn't necessarily need it for that portion of the shooting, we were tied to an f-stop that would hold depth of field over the length of the model. So we needed a powerful laser to get the exposure because we were spreading that sucker over a fifty-foot span; and not only did it have to penetrate the smoke, but it had to expose it to the camera as well. And that was real hard to do.

Did Doug Trumbull's people shoot the Enterprise *that was composited into those shots?*

Some of it. We sent one of our VistaVision cameras down there and they shot some double-pass elements for us that were used where you could see the *Enterprise* close up, like with the entry to the maw. But for some of the more distant shots we built and photographed a smaller version of the *Enterprise*, about a foot long. We even shot photographs and used still cutouts in some places. Whatever worked. Every technique in the book was used on this one, and then some.

Continuing on in that sequence, we come to the energy probe which penetrates the *Enterprise* defenses and then moves around the bridge for a while reading the computers before it decides to eat Persis. The basic live-action footage for that sequence was shot to Bob Abel's specifications and was done in 65mm. We reduced it to VistaVision format. The problem was that we didn't know how he was going to do the effect. I'm sure it was shot to fit whatever concept he had in mind — we just didn't happen to know what that was. What Abel used was a large strobe unit about six feet tall and a guy physically moving it around the stage during the shots. The idea was actually kind of neat, because it covered the entire set with a reactive lighting effect that followed the action of whatever it was we were eventually going to be putting in there. All we had to do was come up with a way to get the light post out and something put in its place. Ultimately, there's a dozen different ways to do any effect, but once someone's decided how to do it and shot the film, it's tough to come up with some other solution that's as elegant. Here we were dealing with a very specifically designed piece of original photography without knowing what the effects concept had been.

So you had no contact with the Abel organization during your work on Star Trek?

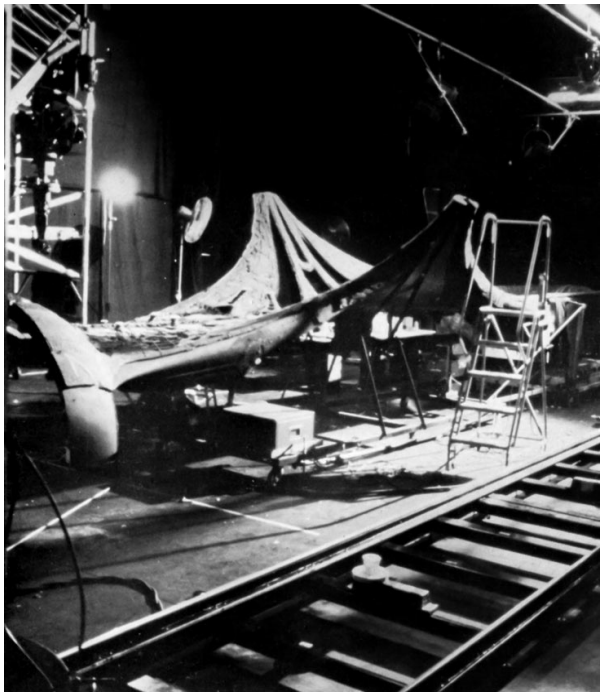
No, that was pretty absolute. I know Bob Abel, and I like him a lot and I respect his work. But I really didn't feel it was my position to go to him and ask how he planned to do a given sequence. It's not that I felt there was any animosity on his part toward the picture or toward me or toward anyone else who was working on it. It's just that when Paramount relieved him of the authority, they relieved him of the responsibility as well — and so he stayed out of it. I'm sure he felt he could have executed the effects and completed the picture; but if they didn't want him to do that, then it wasn't up to him to give away whatever ideas he may have had so that somebody else could do it instead.

Cameraman John Sullivan adjusts the snorkel lens used to photograph extremely close flyby footage over the V'ger surface. / A composite of the V'ger tailsection. The basic engine design was achieved using macrame string art. Clouds were laser-scanned smoke. / The snorkel-lensed VistaVision camera poised over the V'ger midsection. During most of the filming, the stage was filled with diffusing smoke. / Because of the complex actuating mechanism, the V'ger maw was not filmed in conjunction with the rest of the model. Instead, it was photographed by cameraman Doug Smith in a plastic smoke tent at the main facility. / Model maker Michael Joyce adds finishing touches to the engine compartment.

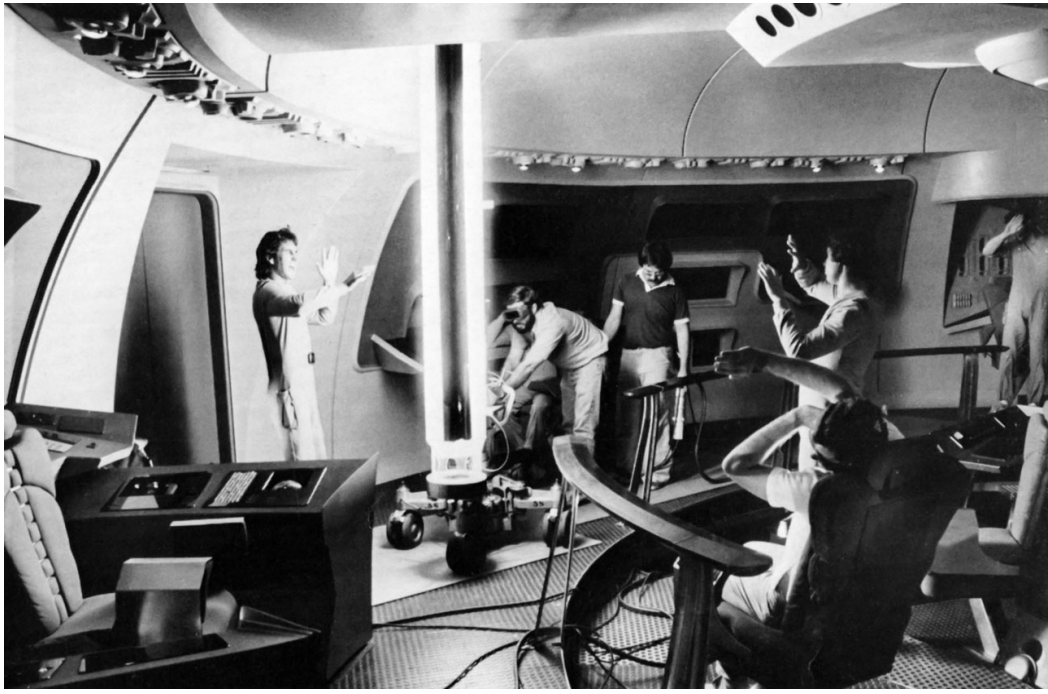
Anyway, Bruce Lane began working on a pellicle system using distortion to remove the parts of the frame we didn't want to show. Basically, it worked on the same principal as a fun house mirror. We took a rear projection unit and put a flexible mylar pellicle at a 45-degree angle to the screen. Then, at 45 degrees to the pellicle, we placed our camera. So what you had was the image being projected onto the screen, then reflected onto the mylar and photographed from the mirrored mylar surface. Behind the pellicle, Mat Beck rigged a probe device which would press forward against the mylar, and whatever image was on the other side would be puckered into a thin sliver. The probe had both an X and Y axis, so it could move up and down and side to side, as well as in and out. By hooking that up to the motion control system, Mat could program it so the distortion effect would track the technician as he moved around the set with his light bar. It was really strange, though, because as the distortion effect progressed across the frame, *everything* would pucker — it would suck people in and then spit them back out again. In fact, there's one scene where the thing moves in front of the control console, and everybody moves two feet to the right by the time it's gone by. The idea was that this whole thing was itself a distortion, and that it would indeed distort visually whatever it happened to be near — at least that was a nice rationalization. By pressing harder or softer against the mylar, you could vary the amount of the scene you sucked in, and as he came closer and closer to the camera, we'd push harder and harder into the mylar to make sure he'd disappear. And of course it was always a distortion of the entire scene, because you kept sucking in more and more image from the sides. It wasn't what I'd call the most sophisticated system, but it worked.

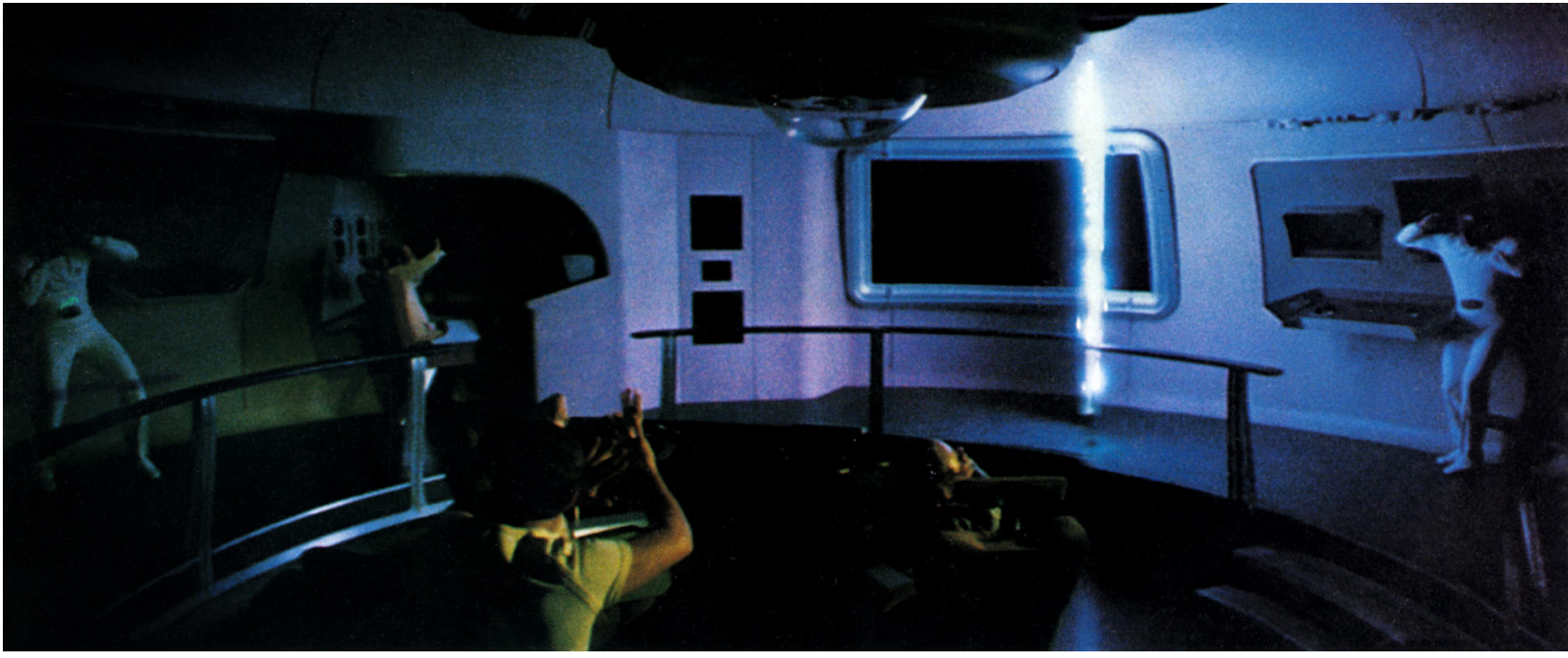
Then, for the effect itself, we experimented around for a long time before we came up with something that Bob Wise found satisfactory. Since Bob Swarthe had come up with the idea of using moire light patterns for the transformation sequence at the end, we thought it would be neat for the energy probe to exhibit the same kind of presence — sort of a three dimensional light form. Harry Moreau had worked for Bob Swarthe and had done a lot of the moire patterns used in *Close Encounters*, so he came up with some techniques of his own for making these moires work out pretty much the same as the stuff Swarthe was doing for the end. That was one of our big breakthroughs with Bob Wise — when we finally came up with something that had character to it and which fit in. Once we had them all worked out, the moving moires were photographed on the animation stand and superimposed over the pellicle distortion created by the probe.

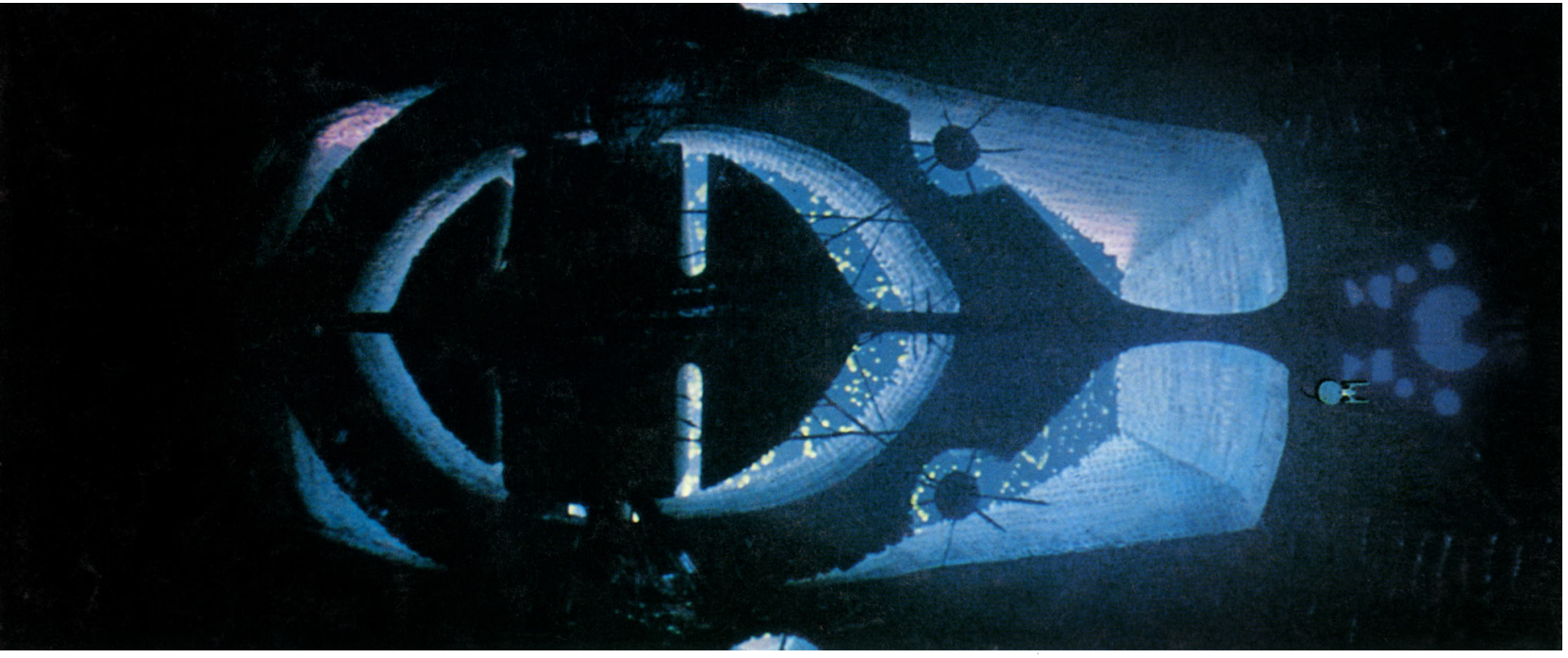
If you watch the sequence closely, though, you can see some interesting things — like every once in a while an elbow will emerge from this giant pillar of light because the guy controlling the strobe stuck it out a little too far. Also, there's glass around the set in various places, and sometimes you can catch a fleeting reflection of a guy with sunglasses on wheeling this monster light around. It's not real obvious, but when you've seen that footage as much as we did around here you can't help scrutiniz-



When completed and assembled in its entirety, V'ger extended some sixty-eight feet. / David Sosalla sculpts a model of Ilia, frozen in flight, to be used in the sequence where the energy probe digitizes her. / The sculpture was implanted with conductive material and photographed with the Tesla coil to produce an arcing representation of Ilia that was then superimposed over the final frames of her live-action image as it disappears from the screen. / The energy probe itself was shot on the Enterprise *bridge at Paramount using a giant strobe light which was wheeled around the set. / The strobe was removed from the scene by projecting each frame onto a flexible mylar mirror, puckering the mylar from behind to squeeze out the undesired portion, and then rephotographing the reflected image. The scintillating lighting effect — shifting moire patterns shot on an animation stand — were then superimposed.*







ing everything — then, once you see something like that, it's impossible to watch the picture *without* seeing it.

All of the electrical discharge stuff in that scene was animated lightning that Harry did. The only part that isn't is the brief shot when the probe zaps Ilia. For that shot, David Sosalla sculpted a small model of her, frozen in the position from which she was supposed to disappear. We covered that with an electrical conductor and filmed it with the Tesla coil — kind of like the digitization effect we used on the Klingons.

The last major thing of ours in the picture was the V'ger maw which opens to inhale the *Enterprise.* That was a separate model from the rest of V'ger and involved a very complicated articulating mechanism which was put together basically by Bill Shourt and John Ramsay and the guys in the model shop. That was shot in smoke, too; but since we didn't have an extra smoke room, we filmed it in kind of a makeshift plastic tent. We did that in about four or five passes, and I think it came out looking really nice.

How was the working relationship between your unit and Doug Trumbull's?

Very close. With the exception of the V'ger exterior — which was about the only thing in the picture where we were pretty much solely in charge of making it come off — just about everything we did had a little bit of something that Doug was doing in it. The Klingon sequence had the cloud; the energy probe on the bridge had the original photography — not that that was Doug's, but it was somebody else's photography that was brought to us. So even though we'd split up the work to a certain extent and were physically separated by about a thirty-minute drive, we *had* to work very closely.

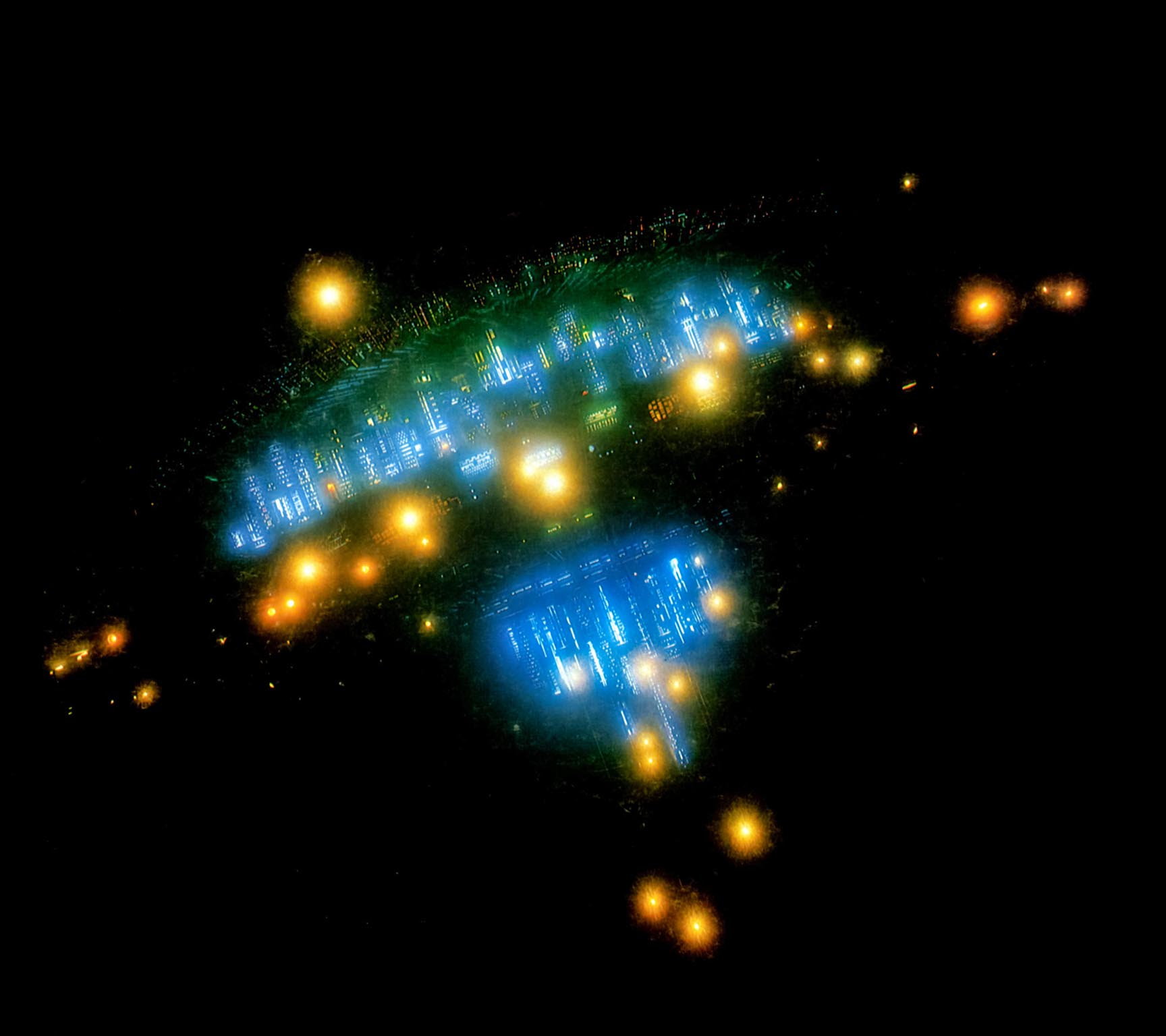
And to be frank with you, I was concerned about that at first. When you take a picture like this one, which was fraught with problems right from the beginning, you often end up in a situation where people start turning on one another — not founded on anything in particular, but just because they don't have anyplace else to direct their anxiety and frustration. Since our work overlapped so frequently, I'm sure that some of the stuff we sent them wasn't quite right, and vice versa; but nobody was ever small enough to start pointing the finger at the other for whatever problems they found themselves in — and believe me, there were plenty of problems. Fortunately, the kind of animosity and resentment I feared might happen just didn't. Everybody was incredibly cooperative.

In fact, the whole thing was really a superhuman effort. It was never a matter of putting in a week's work and then resting up for the next week. It was eight months of straight, nonstop killer work. And to an individual, I don't think there was anyone on this show who didn't become involved in it in a very real sense. Everybody gave a hundred and fifty percent of what they were capable of giving us. People were showing up to see dailies in the morning, and then working until five hours before they had to show up and see dailies again. You can't dictate that kind of dedication — that comes from within. And to me, being in the position of having to take scenes that had already been photographed and come up with a way to make them work, after the fact, makes that kind of response all the more remarkable.

Granted, *Star Trek* was special case, but it's always going to be difficult when the effects crew is brought in after the rest of the picture is finished. The shows that we've been involved in, in a collaborative way, up front have been the ones where the effects work has been the most successful. I can't tell you how many times I've had to tell people I could have saved them half a million bucks if they'd simply dressed a guy in green instead of blue — stupid stuff like that. So it isn't a matter of getting off on the idea of controlling some portion of the production. It really, truly is to save people money. I know that there are films being made right now that don't have effects figured out for them, and the producers are going to end up, not coming to me necessarily, but going to somebody and saying, "Can you fix this up?" And with as many people as there are around now professing to be effects guys, somebody's bound to say "Sure, I can do it." I'm not afraid of the competition, but it's just unfortunate, because the quality of the product suffers severely and that hurts the business.

What do you think of the end result of all your labors?

Well, it's easy to agree with what would seem to be public opinion; but I think Bob Wise should be commended for putting together a movie with a lot of flash, and yet one that was still true to the characters in the television series. People can dream on about what they could have done if those characters had been expanded — but then maybe it wouldn't have been *Star Trek* anymore. If all of a sudden Kirk had started hurling four-letter epithets at people and trying to get a leg over Persis Khambatta, I don't think it would have excited the audience that said it was too much like the TV series, and I'm *sure* it would have turned off a lot of the audience that *did* like the show. I think Bob Wise also deserves a lot of credit for taking what was given to him each day and making the best of it. I know in many cases I was forced into making creative decisions that were probably not totally to his liking — not because I thought my ideas were better than his or anyone else's, but just because I didn't know any other way to execute them. We had two places producing special effects at the rate of three or four shots a day; and with that kind of inertia it was very hard for a director to exert any kind of constructive criticism. People were at the hairy edge anyway, so he had to walk a very tight line in getting whatever modifications he felt were necessary without getting everybody up in arms.

Personally, though, my experience on the production was a pleasant one — other than the workload, which was unreasonable. But that was dictated by the requirements of the film. We went into it knowing we were under the gun. I just feel bad about it, because there *were* a lot of nice things in the film. The effects were good, the acting was good — I just think that somewhere along the line somebody lost track of something very basic. Despite everybody's best efforts, the thing just didn't work as well as we'd all hoped.

The Enterprise's *passage over the V'ger surface took months to photograph. Compositing was done in-camera, with seven to nine identical passes required for each shot. Many shots required thirty or more hours to complete. Although most of the sequence was filmed from a subjective point of view, certain angles utilized a one-foot model of the* Enterprise, *reduced to flyspeck proportions in order to help put the monstrous mechanical organism in proper scale.*